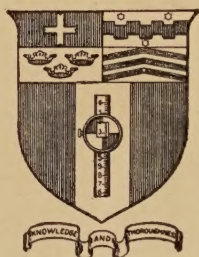


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FOREWORD

"Petroleum Facts and Figures," second edition, brings down to date statistical material contained in the first edition published in 1928. In certain instances, later statistical information was not available; in such cases reference is made to "Petroleum Facts and Figures," first edition.

Several new sections have been added to this book—made possible by the splendid cooperation of the oil companies; and the Public Relations Division of the Institute herewith expresses its appreciation of this support.

Acknowledgment is also made of the assistance given by officials of government bureaus, by oil trade and allied trade associations, and by oil trade and other journals. Among those who have aided materially in this work are John W. Frey, of the Petroleum Section of the Department of Commerce; G. R. Hopkins and E. B. Swanson of the U. S. Bureau of Mines; Stafford Kernan of the Bureau of Aeronautics of the Department of Commerce; E. F. Rochester of the Federal Oil Conservation Board; H. S. Fairbank, of the U. S. Bureau of Public Roads, Department of Agriculture; Harry H. Smith and C. B. Mapes of the Mid Continent Oil and Gas Association; Howard Bennette, of the Western Petroleum Refiners' Association; Earl Newsom and Harry F. Tapp of the Oil Heating Institute; John C. Long of the National Automobile Chamber of Commerce; C. S. Lee and P. Hubbard of the Asphalt Association.

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LEONARD M. FANNING,

*Director, Division of Public Relations
American Petroleum Institute.*

July, 1929.

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PETROLEUM
FACTS AND FIGURES

WORLD PRODUCTION AND CONSUMPTION OF PETROLEUM

WORLD OIL PRODUCTION

In comparing the oil production of 1928 with 1927, it is noted that, with the exception of the United States and Mexico, all the major producing countries of the world showed appreciable increases. In many cases new high records for all time were registered. While the United States produced more oil than during any previous year—with a total of 902,000,000 barrels (preliminary figure)—this was an increase over 1927 of only .09 per cent. In the United States, during 1928, production of oil in certain areas was held in check because of prevailing conditions of oversupply. The Federal Oil Conservation Board (Report III, February 25, 1929) summarizes the petroleum situation in the United States relative to supply and demand as follows:

“ The flow from new wells has more than offset the declining output of old wells ; production has even kept ahead of increasing consumption. This excess of domestic supply over a demand which has increased 20 per cent since 1924 is shown by the stocks of crude oil at the close of business December 31, 1928, which amounted to about 485,000,000 barrels, as compared with 409,000,000 barrels at the end of 1924.”

Thus, in 1928 while this country made a new high record in production, it contributed a smaller percentage of the world's total production than it had for a good many years. Ranking first in oil production among the countries of the world since the Drake well was drilled near Titusville, Pa., in 1859 (except for a few years when Russia lead), the United States contributed 70 per cent or more of the total annual volume of oil brought to the surface consecutively for five years beginning with 1923. In 1928 its contribution declined to 68.2 per cent.

The most significant increases were recorded by Venezuela which, with a production of 106,000,000 barrels in 1928, a gain of 67.9 per cent over 1927, jumped from fourth place to second place; by Russia whose production of 87,800,000

WORLD'S PRODUCTION OF PETROLEUM IN 1928, BY COUNTRIES, COMPARED WITH 1927

	1928		1927		
	Barrels of 42 U. S. gallons	Percentage of total by volume	Barrels of 42 U. S. gallons	Percentage of total by volume	Percentage change 1928 over 1927
United States	902,000,000	68.2	901,129,000	71.5	+ 0.097
Venezuela	106,000,000	8.0	63,134,000	5.0	+ 67.90
Russia	87,800,000	6.7	77,018,000	6.1	+ 14.00
Mexico	50,150,000	3.8	64,121,000	5.1	- 21.79
Persia	42,080,000	3.2	39,688,000	3.1	+ 6.03
Roumania	30,600,000	2.3	26,368,000	2.1	+ 16.05
Netherland East Indies	28,500,000	2.2	25,967,000	2.1	+ 9.75
Colombia	19,900,000	1.5	15,002,000	1.2	+ 32.65
Peru	11,970,000	.9	10,135,000	.8	+ 18.11
Argentina	9,100,000	.7	8,630,000	.7	+ 5.45
India, British	8,300,000	.6	7,878,000	.6	+ 5.36
Trinidad	7,750,000	.6	5,712,000	.5	+ 35.68
Poland	5,530,000	.4	5,342,000	.4	+ 3.52
British Borneo—Sarawak	5,290,000	.4	4,943,000	.4	+ 7.02
Egypt	1,840,000	.1	1,267,000	.1	+ 45.22
Japan and Taiwan ..	1,800,000	.1	1,700,000	.1	+ 5.88
Ecuador	1,090,000	.1	537,000		+ 102.98
Germany	683,000	} .2	663,000	} .2	+ 3.02
Iraq	650,000		200,000		+ 225.00
Canada	618,000		477,000		+ 29.56
France	520,000		504,000		+ 3.17
Sakhalin, Russian ..	509,000		440,000		+ 15.68
Czechoslovakia ..	150,000		149,000		+ 0.67
Italy	43,000	} .2	44,000	} .2	- 2.27
Other Countries ..	23,000		25,000		- 8.00
	1,322,896,000	100.0	1,261,073,000	100.0	+ 4.90

NOTE.—This table shows the output of the various oil producing countries as reported officially to the U. S. Bureau of Mines for 1927 and the estimated production of these countries during 1928. These estimates are based upon information obtained from Consular Officers located in various foreign countries, information received from producing companies and such official figures as are available.

barrels represented an increase of 13.4 per cent; by Roumania with 30,600,000 barrels, an increase of 16.05 per cent; by Colombia with 19,900,000 barrels, an increase of 32.65 per cent; and by Trinidad with 7,750,000 barrels, an increase of 35.68 per cent. Venezuela and Colombia are relatively new producing countries, contrasted with Russia and Roumania which are among the oldest. Trinidad has been producing since about 1908. The only major producing country to show a decrease was Mexico, whose output declined from 64,121,000 barrels in 1927 to 50,150,000 barrels in 1928, or 21.79 per cent.

WORLD'S TOTAL CRUDE OIL PRODUCTION FROM 1857

(Thousands of Barrels of 42 U. S. Gallons)

Country	Date of first recorded production	Total production through 1928	Per cent of total
Roumania	1857	304,840	1.78
United States	1859	11,243,675	65.58
Italy	1860	1,391	.01
Canada	1862	27,352	.16
Russia	1863	2,334,760	13.61
Poland	1874	213,309	1.24
Japan and Taiwan.....	1875	56,809	.33
Germany	1880	19,279	.11
India, British	1889	190,726	1.11
Netherland East Indies.....	1893	391,161	2.28
Peru	1896	95,007	.55
Mexico	1901	1,515,198	8.84
Argentina	1907	52,409	.31
Trinidad	1908	46,391	.27
Egypt	1911	17,279	.10
Persia	1913	300,170	1.75
Sarawak	1913	35,937	.21
Algeria	1914	91	....
Ecuador	1917	2,545	.02
Venezuela	1917	244,259	1.42
France	1918	4,890	.03
England	1919	18	....
Czechoslovakia	1919	1,088	.01
Sakhalin, Russian	1921	43,545	.26
Colombia	1922	1,315	.01
Iraq	1927	850	.01
Others		673	....
Total		17,144,967	100.00

Authority: U. S. Bureau of Mines.

WORLD'S PRODUCTION OF CRUDE PETROLEUM,

[Thousands of barrels

Year	Roumania	United States	Italy	Canada	Russia ¹	Poland (Galicia)	Japan and Taiwan	Germany	India	Netherlands East Indies	Peru	Mexico	Argentina
1857-60	19	502	(²)	...	...	...	...	...	...	...	...	...	...
1861	17	2,114	(²)	...	...	...	...	...	...	...	...	...	...
1862	23	3,057	(²)	12	...	...	...	...	...	...	...	...	...
1863	28	2,611	(²)	83	41	...	...	...	...	...	...	...	...
1864	33	2,116	(²)	90	65	...	...	...	...	...	...	...	...
1865	39	2,498	2	110	67	...	...	...	...	...	...	...	...
1866	42	3,598	1	175	83	...	...	...	...	...	...	...	...
1867	51	3,347	1	190	120	...	...	...	...	...	...	...	...
1868	56	3,646	(²)	200	88	...	...	...	...	...	...	...	...
1869	59	4,215	(²)	220	202	...	...	...	...	...	...	...	...
1870	84	5,261	(²)	250	204	...	...	...	...	...	...	...	...
1871	90	5,205	(²)	270	165	...	...	...	...	...	...	...	...
1872	91	6,293	(²)	308	185	...	...	...	...	...	...	...	...
1873	104	9,894	(²)	365	475	...	...	...	...	...	...	...	...
1874	103	10,927	1	169	585	150	...	...	...	...	...	...	...
1875	108	8,788	1	220	697	158	5	...	...	...	...	...	...
1876	111	9,133	3	312	1,321	164	7	...	...	...	...	...	...
1877	108	13,350	3	312	1,801	170	10	...	...	...	...	...	...
1878	109	15,397	4	312	2,401	176	18	...	...	...	...	...	...
1879	110	19,914	3	575	2,761	215	23	...	...	...	...	...	...
1880	115	26,286	2	350	3,001	229	26	9	...	...	...	...	...
1881	122	27,661	1	275	3,601	287	17	29	...	...	...	...	...
1882	136	30,350	2	275	4,538	330	15	58	...	...	...	...	...
1883	139	23,450	2	250	6,002	365	20	27	...	...	...	...	...
1884	211	24,218	3	250	10,805	408	28	46	...	...	...	...	...
1885	193	21,859	2	250	13,925	465	30	41	...	...	...	...	...
1886	168	28,065	2	584	18,006	306	38	74	...	...	...	...	...
1887	182	28,283	1	526	18,368	344	29	74	...	...	...	...	...
1888	219	27,612	1	695	23,049	467	37	85	...	...	...	...	...
1889	298	35,164	1	705	24,609	515	53	68	94	...	...	...	...
1890	383	45,824	3	795	28,691	659	52	108	118	...	...	...	...
1891	488	54,293	8	755	34,573	631	53	109	190	...	...	...	...
1892	593	50,515	18	780	35,775	646	69	101	242	...	...	...	...
1893	535	48,431	19	798	40,457	693	106	100	299	600	...	...	...
1894	508	49,344	21	829	36,375	949	173	123	327	688	...	...	...
1895	578	52,892	26	726	46,140	1,453	170	121	372	1,216	...	...	...
1896	543	60,960	18	727	47,221	2,444	237	145	430	1,427	47	...	...
1897	571	60,476	14	710	54,399	2,226	262	166	546	2,552	71	...	...
1898	776	55,364	15	758	61,610	2,376	319	184	542	2,964	71	...	...
1899	1,426	57,071	16	808	65,955	2,314	539	192	941	1,796	89	...	...
1900	1,629	63,621	12	913	75,780	2,347	871	358	1,079	2,253	274	...	...
1901	1,678	69,389	16	757	85,168	3,251	1,117	314	1,431	4,014	275	10	...
1902	2,060	88,767	19	531	80,540	4,142	966	354	1,617	2,430	287	40	...
1903	2,763	100,461	18	487	75,591	5,235	1,209	446	2,510	5,770	278	75	...
1904	3,599	117,081	26	553	78,537	5,947	1,219	637	3,385	6,508	290	126	...
1905	4,421	134,717	44	634	54,960	5,766	1,347	561	4,137	7,850	373	251	...
1906	6,378	126,494	54	569	58,897	5,468	1,564	579	4,016	8,181	531	502	...
1907	8,118	166,095	60	789	61,851	8,456	1,718	757	4,344	9,983	751	1,005	(²)
1908	8,252	178,527	51	528	62,187	12,612	1,871	1,009	5,047	10,283	945	3,933	12
1909	9,327	183,171	42	421	65,970	14,933	1,887	1,019	6,677	11,042	1,411	2,714	18
1910	9,724	209,557	51	316	70,337	12,673	1,829	1,032	6,138	11,031	1,258	3,634	20
1911	11,108	220,449	75	291	66,184	10,519	1,737	1,017	6,451	12,173	1,465	12,563	13
1912	12,976	222,935	54	243	68,019	8,535	1,659	1,031	7,117	10,846	1,752	16,558	47
1913	13,555	248,446	47	228	62,834	7,818	1,940	857	7,930	11,172	2,071	25,696	131
1914	12,827	265,793	40	215	67,020	6,436	1,636	781	7,410	11,422	1,837	26,235	276
1915	12,030	281,104	44	215	68,548	5,352	2,928	703	8,202	11,920	2,579	32,911	513
1916	8,945	300,767	51	198	65,817	6,587	2,963	656	8,491	12,547	2,593	40,546	867
1917	3,721	335,316	41	214	63,072	6,228	2,861	642	8,079	13,180	2,577	55,293	1,218
1918	8,730	355,928	35	305	27,168	6,032	2,441	270	8,188	12,778	2,527	63,828	1,353
1919	6,618	378,367	35	241	31,752	6,096	2,238	265	8,736	15,508	2,628	87,073	1,331
1920	7,435	442,929	35	196	25,430	5,607	2,221	246	8,375	17,529	2,817	157,069	1,651
1921	8,368	472,183	32	188	28,968	5,167	2,233	274	8,734	16,958	3,699	193,398	2,036
1922	9,843	557,531	31	179	35,692	5,227	2,055	319	8,529	17,066	5,314	182,278	2,866
1923	10,867	732,407	34	170	39,147	5,402	1,804	346	8,406	19,870	5,699	149,585	3,400
1924	13,369	713,940	45	161	45,355	5,657	1,814	406	8,416	20,473	8,379	139,678	4,639
1925	16,650	763,743	70	332	52,448	5,960	1,915	541	8,274	21,422	9,252	115,515	6,336
1926	23,314	770,874	48	364	64,311	5,844	1,900	653	8,728	21,242	10,762	90,421	7,952
1927	26,368	901,129	44	477	77,018	5,342	1,700	663	8,778	25,967	10,135	64,121	8,630
1928	30,600	902,000	43	618	87,800	5,530	1,800	683	8,300	28,500	11,970	60,150	9,100
1929	304,840	11,243,675	1,391	27,352	2,334,760	213,309	56,809	19,279	190,726	391,161	95,007	1,515,198	52,409

¹ Exclusive of Sakhalin, which is shown separately. ² Estimated. ³ Less than one thousand. ⁴ Production in previous years credited to Germany. ⁵ Included in others.

Authority: U. S. Bureau of Mines

FACTS AND FIGURES

7

1857-1928, BY YEARS AND COUNTRIES

of 42 U. S. gallons]

Trini- dad	Egypt	Persia	Sara- wak	Al- geria	Ecu- dor	Vene- zuela	France	Eng- land	Czecho- slova- kia	Sak- halin (Rus- sian)	Col- om- bia	Iraq	Other coun- tries ²	Total	Percent- age pro- duced by United States	
.....														521	96	
.....														2,131	99	
.....														3,092	99	
.....														2,763	94	
.....														2,304	92	
.....														2,716	92	
.....														3,899	92	
.....														3,709	90	
.....														3,990	91	
.....														4,696	90	
.....														5,799	91	
.....														5,730	91	
.....														6,877	92	
.....														10,838	91	
.....														11,933	92	
.....														9,977	88	
.....														11,051	83	
.....														15,754	85	
.....														18,417	84	
.....														23,601	84	
.....														30,018	88	
.....														31,993	86	
.....														35,704	85	
.....														30,255	78	
.....														35,969	67	
.....														36,765	59	
.....														47,243	59	
.....														47,807	59	
.....														52,165	53	
.....														61,507	57	
.....														76,633	60	
.....														91,100	60	
.....														88,739	57	
.....														92,038	53	
.....														89,337	55	
.....														103,692	51	
.....														114,199	53	
.....														121,993	50	
.....														124,979	44	
.....														131,147	44	
.....														149,137	43	
.....														20	167,440	41
.....														26	181,809	49
.....														36	194,879	52
.....														40	217,948	54
.....														30	215,091	63
.....														30	213,263	59
.....														30	263,957	63
.....														30	285,287	63
.....														20	298,709	61
.....														20	327,763	64
.....														20	344,361	64
.....														20	352,443	63
.....														20	385,345	64
.....														20	407,544	65
.....														10	432,033	65
.....														25	457,500	66
.....														29	502,891	67
.....														25	503,515	71
.....														20	555,875	68
.....														20	688,894	64
.....														20	765,935	62
.....														22	858,898	65
.....														24	1,015,735	72
.....														24	1,014,324	70
.....														23	1,068,962	71
.....														21	1,098,389	70
.....														25	1,261,473	72
.....														23	1,322,896	68
.....																
46,391	17,279	300,170	35,937	91	2,545	244,259	4,890	18	1,088	1,315	43,545	850	673	17,144,967	65	

¹ Exclusive of Sakhalin, which is shown separately. ² Estimated. ³ Less than one thousand. ⁴ Production in previous years credited to Germany. ⁵ Included in others.

Authority: U. S. Bureau of Mines

Iraq conspicuously appeared in the list of oil producing countries of the world in 1928, with an output of 650,000 barrels, as against 200,000 barrels in 1927.

Production of oil on a commercial scale in the United States began in 1859. Since first recorded production in 1857, the United States has produced 65.4 per cent of the world's output, as follows:

TOTAL PETROLEUM PRODUCTION, 1857-1928

	Barrels
World	17,144,967,000
United States	11,243,675,000

It is interesting to note that while twenty-six individual countries have commercially produced petroleum, eight of these contributed 96.5 per cent of the world's total recorded production through 1928, with the remaining fifteen countries each contributing less than one per cent of the total production. In most of the latter countries more intensive drilling may be expected to increase the output.

PETROLEUM RESOURCES OF FOREIGN COUNTRIES AND OUTLYING POSSESSIONS OF THE UNITED STATES

Figures of actual production do not give a complete picture—and in fact may be misleading—of the petroleum resources of the different oil producing countries. A country producing a relatively small amount at the present time may have great known oil potentialities. Development may be retarded for a number of reasons, such as inaccessibility; artificial, economic, and political restrictions. In countries other than those listed there are known possibilities and probabilities of oil accumulation.

The report "Petroleum Resources of Foreign Countries and Outlying Possessions of the United States"¹ gives the following summary of the geologic principles of accumulation of petroleum and the geographic distribution of oil:

¹ Appendix C, p. 50, Report III of the Federal Oil Conservation Board, Feb. 25, 1929, prepared by A. H. Redfield of the U. S. Bureau of Mines.

“ According to theories generally held by geologists and to the experience of 70 years in producing petroleum, commercial accumulations of petroleum and natural gas are most likely to occur—

“ 1. In areas of sedimentary beds, at least in part of marine origin and not older than Cambrian or younger than Pliocene.

“ 2. In successions of alternating porous beds, such as sand, sandstone, gravel, conglomerate, dolomite, or cavernous limestone and impervious beds, such as clay, shale, marl, or compact limestone, especially where layers originally rich in organic matter are present.

“ 3. In moderately folded or faulted beds, more rarely in overturned folds or along overthrust faults.

“ In general, accumulations of commercial size do not occur—

“ 1. In metamorphic or altered sedimentary rocks.

“ 2. In igneous rocks, except in rare cases.

“ 3. In sedimentary strata which are excessively intruded by or interbedded with igneous rocks.

“ 4. In sedimentary strata which are excessively folded, faulted, overturned, or overthrust.

“ GEOGRAPHIC DISTRIBUTION

“ The possibilities of the continents for containing commercial pools of oil and gas differ considerably. North America, with the gently folded Cretaceous and Tertiary beds of its southern coastal plain, with the moderately folded Paleozoic and Mesozoic strata of its great interior plains and plateaus, and its folded Tertiary and Cretaceous formations of the Pacific Coast Ranges and interior valleys may be considered richest of the continents in oil. The United States alone has already produced, from 1859 to the end of 1927, more than 10,333,300,000 barrels of oil. Although fully half of Canada is occupied by a great block of ancient crystalline rocks, so greatly disturbed, altered, and eroded that oil is not likely to be found in them, possibilities of future production exist not only in Ontario and the maritime Provinces which have already yielded a small amount of oil but especially in the prairie Provinces and in the Northwest Territories. Central America, the West Indies, and most of Mexico consist largely of mountain ranges too highly disturbed to contain large areas of possible oil land

comparable to those of the interior United States; the Gulf coastal plain of Mexico, however, has proved astonishingly rich and gives promise of future production.

“ In the imperfectly explored and largely undeveloped South American Continent the best possibilities for the accumulation of petroleum occur in the folded Tertiary beds of the northern and western margins, of which those in Peru, Ecuador, Colombia, and Venezuela have already yielded considerable oil; in the little-known Paleozoic rocks of the Amazon basin; in the Paleozoic and Mesozoic of the Bolivian Chaco and the Argentine pampas as verified by the discovery of oil in Argentina, and more recently in Bolivia; and in a few basins of Paleozoic and Mesozoic let down into the Andes. The larger part of Brazil, most of Venezuela south of the Orinoco River, and almost all of the three Guianas are covered by ancient crystalline rocks in which oil or gas are not likely to be found.

“ The rocks of western and central Europe are too broken and disturbed to afford great areas of oil land; many small fields undoubtedly will be developed in addition to the known fields, in Alsace, Languedoc, Hanover, Galicia, Roumania, Moravia, northern Italy, Albania, and Spain. In eastern Europe, beneath the great plains of Russia and of the Baltic Republics are broadly folded Paleozoic and Mesozoic beds like those in which the Appalachian and Mid Continent oil fields occur in the United States, as well as the folded Tertiary formations on the flanks of Caucasus which have yielded from 1821 to the end of 1927 more than 2,250,000,000 barrels of oil. In northern Europe, Finland, Sweden, and Norway are almost entirely composed of rocks too ancient and altered or too highly disturbed to give any promise of containing commercial accumulations of oil or gas. Too little is known of the nature and structure of the rocks underlying the flat surface formations of the Netherlands and Denmark to warrant any estimate of their oil or gas possibilities.

“ Asia, geologically far less known than Europe or North America, is largely plateaus of ancient crystalline rocks and mountains of highly disturbed rocks ranging in age from Paleozoic to Tertiary. The largest areas of moderately disturbed sedimentary beds in Asia lie in Russian central Asia, in Iraq (Mesopotamia) and southwestern Persia, in the Punjab, in Burma, in Szechwan and Shensi Provinces, China, and in the Netherland East Indies. In all of these areas

the presence of oil has been proved by the drill. In addition, some oil has been found in the plains of little-known western Siberia. Some possibilities of commercial accumulations of oil occur in the southwestern limestone plateaus of Arabia, Syria, and Palestine. In the islands that fringe the eastern coast of Asia, oil has been obtained from folded Tertiary beds in northern Sakhalin, in Japan, and in Taiwan (Formosa), and indications are favorable that some day oil will be found in the Philippine Islands. However, in general the oil possibilities of Asia do not appear large in comparison with the vast area of the continent.

“ Africa consists largely of old crystalline and altered sedimentary rocks partly covered in the south and center by little-disturbed sedimentary beds of dry-land or fresh-water origin, and in the north by great plateaus of limestone and continental sandstone, with little or no marine shale rich in organic matter. Whatever oil Africa has produced or will ever produce must be sought in the folded Mesozoic and Tertiary beds which in places fringe its margins. Up to the present time only a small output has been obtained in Egypt from sharply folded and faulted Tertiary beds along the Red Sea; and an insignificant amount in Algeria, Tunisia, and Morocco from overfolded and overthrust Tertiary beds. Favorable indications have led to recent test drilling in Angola, in Mozambique, and in Madagascar; and in the past to inconclusive drilling in Nigeria and the Gold Coast.

“ Australia, like Africa, has too many ancient crystalline rocks and beds of dry-land origin in its make-up to warrant much hope of extensive oil lands. Some possibilities may exist in the basins of Mesozoic and Tertiary rocks down-faulted into the highly disturbed older rocks of the eastern highland, and perhaps in the gently folded Jurassic beds which underlie the broad Artesian Basin of interior Queensland, although these are of fresh-water origin. The highly disturbed sedimentary rocks of New Zealand have never yielded and probably never will yield more than small amounts of oil and gas.

“ The innumerable islands of the Pacific Ocean, composed like the Hawaiian Islands almost entirely of volcanic flows, or like the Samoan group chiefly of coral limestone, give no promise of ‘ oil or gas.’ ”

It is brought out that in more than fifty other countries which at present produce no oil or gas, seepages and other

visible indications, as well as the general geology, encourage the belief that commercial pools will yet be discovered. It is the province of the geologist to determine which of these undeveloped areas are the most likely to yield oil and gas. Much can be presumed on the basis of the known geology of a particular area. Far more, however, remains to be determined by careful geologic field examination of specific localities and by actual drilling.

NOTE.—For more detailed information on location of oil in foreign countries, see "Petroleum Facts and Figures," first edition.

AMERICA'S RELATIVE SITUATION

"The United States is preeminently the chief producer of oil in the world," says the Federal Oil Conservation Board (Report III).

"During 1928, Texas and Oklahoma each produced more petroleum than the three leading foreign countries—Venezuela, Russia, and Mexico—combined. The total production of the 20 oil-producing states was about 68 per cent of the world's crude oil production, while our domestic consumption, exclusive of the addition to storage, was approximately 64 per cent of the world total. Contrasted with these large percentages for a single country are the figures for all the other countries, whose demand for petroleum products must now tend to increase, possibly even more rapidly than our own demand. Roughly the United States is producing and consuming twice as much petroleum as the rest of the world. Our distribution of oil to other countries, chiefly in the form of refinery products, is a large and notable item in world trade.

"Neither the high rate of domestic consumption nor the excess of exports over imports would be disquieting if the petroleum resources of the United States bore anything like the same ratio to the world's resources as the production ratio of 68 per cent. According to the present opinion of our best petroleum geologists, our total resources, instead of being 68 per cent of those of the world, are not more than 18 per cent. If our petroleum reserves are not to be drawn upon at a faster rate than those of all other countries, our resources should be several times larger.

“ The obvious inference is that the United States is exhausting its petroleum reserve at a dangerous rate. If the international comparison is made, this country is depleting its supply several times faster than the rest of the world. How real is the danger expressed in this fact and what remedy can be devised are questions confronting the American people as they plan for the future. At least, the effort should be made to propose measures that will minimize and delay the undesirable future outcome of this excessive drain upon a limited though admittedly large reserve. In this planning for the future the principal units of the oil industry itself, with their large refinery capacity and distribution systems, both domestic and foreign, have a stake second only to that of the Nation and may well be counted on to join forces in the common interest. The depletion rate of our own resources can be brought more into accord with that of foreign resources only in one way—by importing a greater quantity of crude petroleum. The present imports of Mexican and South American crude oil come largely from American operators and, while not obtained from United States oil sands, they are the product of American engineering and enterprise. Cooperation in the development of foreign oil fields, through technical assistance and the further investment of American capital, would seem to be a logical conservation measure.

“ It may be assumed in advance that for reasons which have been mentioned in previous reports, although greater economy of use may be attained, this alone will not appreciably flatten the curve of our constantly increasing consumption. At the present time no other means of limiting the use of petroleum products or lessening the gross amount consumed is apparent other than the usual economic control exercised by price.”

STUDIES RELATIVE TO WORLD PRODUCTION AND CONSUMPTION

Factors affecting the relative position of the United States in the international aspects of the problem of petroleum conservation are still under consideration by the Federal Oil Conservation Board and the technical advisors in the federal bureaus. (See Appendix “ Conservation of Petroleum.”)

Specifically, the studies relate to trends in world production and consumption of crude petroleum and refined oils;

development of refining capacities in foreign countries and the consequent ability to supply increasing proportions of foreign demand from sources outside of the United States; international movements of petroleum products and the extent to which definite consuming areas are dependent for petroleum products upon producing areas; and the legislative and other factors affecting the development, production, and movement of crude petroleum and its refined products.

The American Petroleum Institute has a Committee on World Production and Consumption of Petroleum and Its Products. (See Appendix "Conservation of Petroleum.") This committee has been organized with a view to making studies, among other things, to effect cooperation with other nations in the world-wide conservation and orderly development of petroleum deposits; to consider what may, or should be, the attitude of countries which are producing petroleum, as differing from those countries which do not produce.

In the early part of 1929, a Webb-Pomerene "Petroleum Export Association" was formed by the major American companies having important, long-established foreign interests in petroleum export marketing.

CONSERVATION AS AN INTERNATIONAL PROBLEM

"Conservation is an international problem, the neglect of which will react in varying degree upon every producing area and consuming market, and the benefits of which will not be the monopoly of any country or group of countries, but will be the common heritage of all. Lacking recognition on the part of the crude producing countries that through the premature and excessive development of existing fields, the full economic value of the production of these fields is being lost to the world and the requirements of the future menaced, conservation of petroleum is impossible of attainment.

"It is beyond the power of any group of interests effectively to regulate the production of petroleum in conformity

with the world's needs without a general participation in these policies by a great preponderance of the producing industry. The growing conviction that cooperation in the production of petroleum, in order to attain its full economic value to the consumer of the present and the future, is a responsibility which rests upon crude producing countries has been exemplified in the existence of certain shut-in fields abroad and in the action taken with the approval of the state governments by the producers in Seminole (Oklahoma) and West Texas."—The Lamp, April, 1929.

WORLD TRANSPORTATION OF PETROLEUM

All the oil producing fields of the world are connected by railroads or pipe lines either with seacoast terminals or with refineries. Thence crude oil, or refined products, are transported by tank steamer, tank car and tank trucks to the markets. Tanker fleets, almost entirely owned by oil companies, comprise a substantial percentage of the world's merchant tonnage.

WORLD TANKERS *
(500 Gross Tons and Over)

Year	Steam and motor		Sail and barge		Total	
	Number	Gross	Number	Gross	Number	Gross
1928.....	1,182	6,578,351	124	161,785	1,306	6,740,136
1927.....	1,050	5,640,321	116	149,913	1,166	5,790,234
1926.....	1,001	5,375,854	106	143,620	1,107	5,519,474
1925.....	961	5,156,766	111	153,767	1,072	5,310,533
1924.....	952	5,103,909	89	137,874	1,041	5,241,783
1923.....	938	5,013,484	98	147,050	1,036	5,160,534
1922.....	852	4,662,618	98	143,786	950	4,806,404
1921.....	745	3,790,166	95	144,661	840	4,114,827
1920.....	582	2,929,521	91	138,609	673	3,068,130
1919.....	536	2,644,226	89	129,041	625	2,773,267
1914.....	320	1,352,057	46	89,139	366	1,441,196

* Exclusive of Navy, Admiralty, and other Government tankers.

WORLD TANKERS^a
(500 Gross Tons and Over)

Flag	June 30, 1914				June 30, 1927				June 30, 1928			
	Steam and motor		Sail and barge		Steam and motor		Sail and barge		Steam and motor		Sail and barge	
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross
American ^b	26	94,466	28	56,219	54	150,685	389	2,304,325	95	118,279	484	2,422,604
Argentine.....	..	..	..	..	..	..	6	18,946	3	4,598	9	23,244
Belgian.....	8	25,811	..	..	8	25,811	6	39,684	3	..	17	76,870
British.....	181	815,849	7	21,561	188	837,410	372	2,008,430	4	14,593	376	2,023,023
Chinese.....	..	..	..	..	..	..	1	510	..	..	1	510
Cuban.....	..	..	..	..	..	..	4	11,176	4	4,125	8	15,301
Danish.....	..	..	1	735	1	735	3	12,660	..	..	3	12,660
Danish.....	..	..	..	..	..	..	13	113,003	..	..	13	113,003
Dominican.....	..	..	..	..	..	..	1	1,970	..	..	1	1,970
Dutch.....	27	72,766	8	8,642	35	81,408	57	187,295	3	2,207	60	189,502
Ecuadorian.....	..	..	..	..	..	..	1	2,210	..	..	1	2,210
Finnish.....	..	..	..	..	..	..	1	691	..	..	1	691
French.....	3	11,222	..	..	3	11,222	25	137,941	..	..	25	137,941
German.....	46	215,844	1	728	47	216,572	21	85,177	..	..	21	85,177
Greek.....	..	..	..	..	..	..	1	1,633	..	..	..	..
Italian.....	3	16,007	..	..	3	16,007	48	208,034	..	..	48	208,034
Japanese.....	4	19,808	..	..	4	19,808	11	42,125	..	..	11	42,125
Mexican.....	4	13,464	..	..	4	13,464	2	11,716	5	3,770	7	15,486
Moroccan.....	..	..	..	..	..	..	2	522	..	..	1	522
Norwegian.....	9	48,042	1	1,254	10	49,296	58	364,828	..	..	58	364,828
Panamanian.....	..	..	..	..	..	..	..	..	..	..	..	..
Peruvian.....	..	..	..	..	..	..	1	6,163	..	..	1	6,163
Philippine.....	..	..	..	..	..	..	1	2,296	..	..	1	2,296
Portuguese.....	..	..	..	..	..	..	3	3,392	..	..	3	3,392
Rumanian.....	6	14,371	..	..	6	14,371	3	9,270	3	9,270	3	14,893
Russian.....	1	672	..	..	1	672	2	6,505	6	6,505	6	22,661
Spanish.....	1	2,092	..	..	1	2,092	10	31,836	12	35,662	12	35,662
Swedish.....	..	..	..	..	..	..	3	16,270	5	28,642	5	28,642
Uruguayan.....	..	..	..	..	..	..	1	630	..	..	1	630
Venezuelan.....	..	..	..	..	..	..	5	10,669	2	2,341	7	13,010
Total.....	320	1,352,057	46	89,139	366	1,441,196	1,050	5,640,321	116	149,913	1,166	5,790,234
											124	161,785
												1,306
												6,740,135

^a Exclusive of Navy, Admiralty, and other Government tankers.

^b Including tankers on Great Lakes.

Authority: All figures, except for American tankers, are prepared from Lloyd's Register.

Of the total merchant tonnage (steam and motor vessels) registered under the American flag, about 17 per cent is composed of tank steamers. Tankers comprise 10 per cent of all world tonnage. The tonnage of world tankers in 1914 amounted to 1,441,000 gross tons. By the end of the war (1919) the tonnage had increased to 2,773,000 gross tons; by 1927 to 5,790,000 gross tons, and by 1928 to 6,740,000 gross tons.

American tankers represented a tonnage of 151,000 gross tons in 1914; in 1927, 2,423,000 gross tons; and in 1928, 2,439,000 gross tons. British tanker tonnage in 1928 took the leading position (which it had yielded for several years) from American tonnage, with a total 2,510,000 gross tons. In 1914, Great Britain was far in the lead, with 837,000 gross tons.

The growth of tanker fleets by countries is shown in the table on page 16.

PETROLEUM REFINERIES IN FOREIGN COUNTRIES

By reason of the fact that about 70 per cent of the world's petroleum production is within its territorial limits, the petroleum refining industry in the United States far exceeds that of all other countries combined. Refinery development largely centers in countries having crude oil production, although there are also refineries in non-producing countries. In recent years, petroleum development in several foreign countries has contributed to the establishment and increase of petroleum refineries in these lands.

Many of the refineries abroad are small plants, by no means covering the complete range of refining operations, and having a crude oil capacity of only a few hundred barrels a day. Some refineries listed in a survey issued in Trade Information Bulletin No. 484, June, 1927, by the Bureau of Foreign and Domestic Commerce, U. S. Department of Commerce, have a capacity of less than 100 barrels a day, and are chiefly compounding plants. (See "Petroleum Facts and Figures," first edition.)

The United States probably accounts for 85 per cent of the world's refining capacity. Because of the great amount of refinery equipment in the United States, large quantities of crude oil are imported from foreign countries, particularly from Mexico and the republics of northern South America, for manufacture into the various products. Moreover, this country's refinery development has resulted in a large export business from the United States to supply foreign countries that are without either crude oil resources or adequate refining facilities, or both.

On January 1, 1929, there were 413 completed petroleum refineries in the United States, with a total daily crude oil capacity of 3,509,540 barrels, according to the U. S. Bureau of Mines. (See "Refineries and Refining in the United States.") In addition, 14 refineries, with a potential capacity of 99,000 barrels, were being constructed. Of the completed refineries 341 with a capacity of 3,325,890 barrels, or 95 per cent of the total capacity, were in operation; and 72 with a capacity of 183,650 barrels, or 5 per cent of the total, were shut down.

Constant changes in refining capacities and equipment make any study of foreign refineries of slightly more than general use. (For details on refineries in foreign countries, see "Petroleum Facts and Figures," first edition.)

WORLD CONSUMPTION OF OIL

The United States, with the largest production and the greatest refinery capacity, consumes more oil than any country in the world. In no small part the relatively high consumption in this country has been due to the necessity of meeting the demand for gasoline for the motor car.

Production of petroleum in America dates back to 1859, and from the earliest days the United States has supplied the bulk of the world's oil.

The first important use to be discovered for petroleum was as a burning oil in lamps. Before the general introduction of electricity, kerosene or its predecessor, "coal oil," gave

the world light, and the world had to come to the United States for a large part of its supply.

The industrialization and mechanization of Europe created a vast market for lubricants.

In the early days of the twentieth century, automotive development in the United States began to make great forward strides, and by 1910 the automobile was creating a new demand for gasoline—a petroleum product. The obvious success of the petroleum industry's efforts to supply this hitherto unprecedented demand for gasoline, created by the phenomenal growth of the automobile, has resulted in the parallel growth of these two giant industries, whose prosperity is so vital to the economic welfare of the United States.

The world was brought to a full realization of the essential importance of petroleum in every-day life, in industry, and in safeguarding national security, by the World War. The great development in the use of fuel oil in factories and in ships, the remarkable strides of aviation, with its attendant demand for specialized fuels and lubricants, also had their inception during the war.

As of January 1, 1929, a world census accounted for 31,778,203 motor vehicles in universal use. This represented an increase of 2,090,704 motor vehicles, or a little more than 7 per cent, over total registrations as of January 1, 1928.

WORLD MOTOR VEHICLE REGISTRATIONS BY YEARS

December 31	United States	Outside United States	Total World
1916.....	3,512,996	719,246	4,232,242
1919.....	7,565,446	1,286,948	8,852,394
1920.....	9,231,941	1,710,983	10,942,924
1921.....	10,464,715	2,254,785	12,719,500
1922.....	12,239,853	2,379,091	14,618,944
1923.....	15,092,177	3,120,525	18,212,702
1924.....	17,595,373	3,862,294	21,455,971
1925.....	19,954,347	4,519,282	24,473,629
1926.....	22,001,393	5,648,874	27,650,267
1927.....	23,133,243	6,554,256	29,687,499
1928.....	24,493,124	7,285,079	31,778,203

WORLD REGISTRATIONS OF MOTOR VEHICLES, JANUARY 1, 1929

Countries	Passenger cars	Buses	Trucks	Total	Population per M. V.
Aden.....	379	74	41	494	113
Afghanistan.....	300	.....	218	518	23,166
Alaska.....	1,581	.....	661	2,242	24
Albania.....	295	.....	80	375	2,219
Algeria.....	33,000	880	5,200	39,080	155
Antigua.....	241	2	30	273	108
Argentina.....	259,120	2,200	49,485	310,805	34
Asir.....	14	16	.....	20	75,000
Australia and Tasmania.....	418,173	2,152	96,370	516,695	12
Austria.....	17,600	.....	*11,800	29,400	228
Azores Islands.....	680	28	14	722	321
Bahamas.....	837	7	304	1,148	48
†Bahrein.....	200	.....	5	205	585
Baluchistan.....	955	.....	*310	1,265	532
Barbados.....	1,189	125	172	1,486	114
§Belgian Congo.....	2,000	.....	1,750	3,750	2,265
Belgium.....	72,863	1,200	39,322	113,385	70
Bolivia.....	1,400	85	850	2,335	1,113
†Borneo, British North.....	55	.....	15	70	3,680
†Borneo, Netherlands.....	1,900	.....	200	2,100	7,745
Brazil.....	109,000	1,200	55,000	165,200	223
British East Africa.....	8,085	165	4,250	12,500	812
British Southwest Africa.....	1,366	2	546	1,914	131
Bulgaria.....	1,888	440	194	2,522	2,174
Canada.....	930,405	1,618	129,807	1,061,830	9
†Canary Islands.....	3,409	.....	1,524	4,933	96
Ceylon.....	12,659	2,314	2,338	17,311	296
Chile.....	19,610	1,670	4,160	25,440	158
China.....	17,814	.....	*7,767	25,581	17,000
†Chosen.....	2,022	.....	470	2,492	7,950
†Colombia.....	9,500	.....	5,500	15,000	520
Cook Islands.....	62	.....	52	114	122
Costa Rica.....	1,115	172	364	1,651	286
Cuba.....	28,610	1,773	11,000	41,383	86
†Cyprus.....	1,447	.....	350	1,797	181
Czechoslovakia.....	33,070	1,460	12,570	47,100	305
Danzig.....	1,486	72	724	2,282	168
Denmark.....	76,500	1,100	21,000	98,600	35
Dominica.....	30	.....	3	33	1,136
Dominican Republic.....	3,383	11	954	4,348	235
Ecuador.....	1,298	68	506	1,872	1,068
Egypt.....	20,933	1,193	2,871	24,997	567
England.....	818,000	38,200	272,000	1,128,200	32
Eritrea.....	140	11	137	288	1,399
Estonia.....	1,560	218	607	2,385	468
Ethiopia.....	411	.....	43	454	22,246
Faroe Islands.....	15	2	22	39	586
Fiji Islands.....	755	41	165	961	179
Finland.....	22,903	1,486	8,769	33,158	107
France.....	740,000	13,000	345,000	1,098,000	37
French Indo-China.....	12,000	650	2,690	15,340	1,294
French West Africa.....	2,385	.....	3,676	6,061	2,234
Gambia.....	76	1	142	219	913
Germany.....	390,000	9,000	132,000	531,000	118
§Gibraltar.....	369	.....	222	591	30
Gilbert and Ellice Islands.....	.....	.....	2	2	13,631
Gold Coast.....	1,604	14	5,110	6,728	342
Greece.....	11,350	2,050	3,850	17,250	359
Grenada.....	308	49	40	397	167
Guadeloupe and Dep.....	959	80	74	1,113	219
Guam.....	178	4	109	291	46
Guatemala.....	2,004	96	702	2,802	876
†Guiana, British.....	1,600	.....	260	1,860	160
†Guiana, Dutch.....	175	.....	125	300	476
†Guiana, French.....	60	.....	32	92	480
Haiti.....	1,978	313	434	2,725	935
Hawaiian Islands.....	33,635	223	7,524	41,382	6
†Hejaz.....	750	70	20	840	1,072
†Honduras.....	303	47	119	469	1,648
†Honduras, British.....	110	.....	40	150	302
Hongkong.....	1,600	.....	*477	2,077	421
Hungary.....	11,997	505	3,860	16,362	520
Iceland.....	300	5	460	765	133
India and Burma.....	92,339	13,782	19,034	125,155	2,548
Iraq.....	2,528	.....	610	3,138	1,011
Ireland, North.....	17,242	790	5,637	23,669	53
Irish Free State.....	33,076	726	6,496	40,298	88
Italy.....	135,900	6,300	35,130	177,330	230
Jamaica.....	4,974	100	1,574	6,648	140
Japan.....	47,197	4,255	22,392	73,844	853
†Kuwait.....	75	.....	.....	75	534

*Indicates Buses and Trucks. †1928 Figures, Bureau of Foreign and Domestic Commerce. ‡From the American Automobile (Overseas Edition). §Indicates Passenger Cars and Buses.
 Figures from Automotive Division, Bureau of Foreign and Domestic Commerce.

WORLD REGISTRATIONS OF MOTOR VEHICLES, JANUARY 1, 1929—Continued

Countries	Passenger cars	Buses	Trucks	Total	Population per M. V.
Latvia.....	1,356	179	709	2,244	822
†Leeward Isles.....	403	13	55	471	259
†Liberia.....	165	.....	60	225	6,660
†Libya.....	260	.....	250	510	1,120
Lithuania.....	1,062	126	219	1,407	1,624
Luxemburg.....	5,775	65	2,000	7,840	36
Madagascar.....	1,584	88	394	2,066	1,752
Madeira Islands.....	370	130	75	575	311
Malaya, British.....	24,927	1,963	4,649	31,539	106
Maltese Islands.....	1,205	290	168	1,663	135
Martinique.....	1,340	15	245	1,600	152
Mauritius.....	2,850	80	435	3,365	114
†Mexico.....	52,500	.....	10,000	62,500	229
†Mocalla.....	115	.....	.....	115	.....
Monaco.....	1,155	40	70	1,265	37
Montserrat.....	28	.....	7	35	346
Morocco, Spanish.....	8847	.....	644	1,491	689
Morocco, French.....	12,968	.....	*4,841	17,809	237
Netherland East Indies (excluding Borneo)...	56,983	5,489	9,720	72,192	692
Netherland West Indies.....	954	8	606	1,568	37
Newfoundland.....	1,774	11	247	2,032	132
New Hebrides.....	.....	.....	25	25	2,240
†New Zealand.....	125,690	1,200	24,564	151,454	9
Nicaragua.....	650	2	90	742	876
Nigeria.....	2,195	4	3,055	5,254	3,516
Norway.....	22,691	1,397	12,664	36,752	75
Nyasaland.....	507	20	400	927	1,395
Palestine.....	2,135	475	709	3,319	267
Panama and Canal Zone.....	5,815	413	299	6,527	76
†Papua.....	42	.....	126	168	1,638
Paraguay.....	604	182	714	1,500	532
Persia.....	3,862	70	1,149	5,081	1,968
Peru.....	7,250	475	4,550	12,275	448
Philippines.....	10,791	2,850	6,702	29,343	406
Poland.....	21,686	2,841	4,896	29,423	923
Portuguese East Africa.....	1,258	12	1,008	2,278	1,369
Porto Rico.....	10,162	415	2,736	13,313	109
Portugal.....	21,066	240	3,830	25,136	223
Reunion.....	900	10	125	1,035	180
Rhodesia, North.....	780	.....	130	910	1,323
Rhodesia, South.....	7,020	.....	1,130	8,150	104
Romania.....	23,585	3,948	3,748	31,281	566
Russia.....	8,750	2,248	10,051	21,049	6,980
Salvador.....	1,535	110	236	1,881	893
Samoa, American.....	18	6	20	44	199
Samoa, Western.....	177	37	75	289	144
Scotland.....	77,000	5,000	27,700	109,700	44
†Seychelles Islands.....	14	.....	.....	14	.....
†Siam.....	4,000	1,150	1,700	6,850	1,435
Sierra Leone.....	§325	.....	239	564	2,582
Society Island (excluding Tahiti).....	16	.....	7	23	1,143
Solomon Island.....	2	.....	5	7	21,428
Spain.....	112,452	.....	*33,636	146,088	151
St. Pierre and Miquelon.....	41	.....	29	70	57
St. Lucia.....	120	7	25	152	338
St. Christopher Nevis.....	183	9	23	215	178
Spitzbergen.....	.....	.....	1	1	1,503
Somaliland, British.....	24	7	23	54	6,383
Somaliland, French.....	102	.....	18	120	1,733
Somaliland, Italian.....	243	.....	208	446	2,018
Sudan, Anglo-Egyptian.....	838	.....	1,258	2,096	3,086
Sweden.....	98,600	2,250	27,000	127,850	47
Switzerland.....	53,768	600	11,239	65,607	60
Syria.....	4,822	166	561	5,549	541
Tahiti.....	294	11	56	361	24
†Taiwan.....	129	311	84	524	7,610
Tonga.....	104	2	64	170	159
†Transjordan.....	144	2	49	195	.....
Trinidad and Tobago.....	4,245	261	1,074	5,580	69
Tunisia.....	7,175	105	705	7,985	270
Turkey.....	6,700	.....	*2,300	9,000	1,516
Union of South Africa.....	114,000	850	11,000	125,850	61
United States.....	21,291,719	92,325	3,109,080	24,493,124	4.9
Uruguay.....	32,400	750	7,270	40,420	42
Venezuela.....	10,800	550	400	11,750	257
Virgin Island (United States).....	447	4	108	559	46
Wales.....	39,800	2,800	14,000	56,600	39
Yemen.....	15	20	.....	35	71,428
Yugoslavia.....	9,800	450	2,000	12,250	1,074
Grand Total, World.....	26,814,442	255,184	4,708,577	31,778,203	58

*Indicates Buses and Trucks. †1928 Figures, Bureau of Foreign and Domestic Commerce. ‡From The American Automobile (Overseas Edition). §Indicates Passenger Cars and Buses.
 Figures from Automotive Division, Bureau of Foreign and Domestic Commerce

At the beginning of 1929, there were circulating in continental United States and Canada 25,554,954 cars, or about 80 per cent of the world total—a proportion that includes approximately 83 per cent of the world's passenger cars and 67 per cent of its trucks and buses.

Four years ago, it was estimated that the world ratio of people to the automobile (as of January 1, 1926) was 71 to 1; a year later, the gap had narrowed to 66 to 1; by 1928, the ratio was about 60 to 1; and at the beginning of 1929, the ratio was 58 to 1.

WORLD AIRCRAFT DEVELOPMENT

Aircraft development in certain countries is making a new market of great potentiality for gasoline and lubricating oils. (See "Utilization of Gasoline.")

WORLD OIL-BURNING SHIPS

The growth in the use of fuel oil for industrial and marine purposes is no less sensational than the increase in the use of gasoline. A tendency on the part of the Great Powers toward conversion of battleships into oil burners was noted just preceding the World War and became an actual devel-

WORLD OIL BURNERS
(500 Gross Tons and Over)

Year	Steam engine		Oil engine		Total	
	Number	Gross	Number	Gross	Number	Gross
1928.....	3,558	18,741,884	1,009	4,572,171	4,567	23,314,055
1927.....	3,373	17,980,414	881	3,674,426	4,254	21,654,840
1926.....	3,311	17,791,690	757	3,035,375	4,068	20,827,065
1925.....	3,214	17,215,342	608	2,157,273	3,822	19,372,615
1924.....	3,086	16,470,202	500	1,558,722	3,586	18,028,924
1923.....	2,917	15,229,946	431	1,248,158	3,348	16,478,104
1922.....	2,694	13,838,178	416	1,166,370	3,110	15,004,548
1921.....	2,474	12,415,181	374	959,471	2,848	13,374,652
1920.....	1,731	8,345,913	290	693,334	2,021	9,039,247
1914.....	441	1,527,728	60	194,019	501	1,721,747

WORLD OIL-BURNING SHIPS^a
(500 Gross Tons and Over)

FACTS AND FIGURES

23

Flag	June 30, 1914				June 30, 1927				June 30, 1928									
	Steam Engine		Oil Engine		Total		Steam Engine		Oil Engine		Total							
	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross	No.	Gross						
American ^b	231	648,048	8	10,316	239	656,364	1,803	9,007,901	130	339,820	1,933	9,347,721	1,835	8,915,397	1,970	9,318,144		
Argentine	6	25,241	6	25,241	10	29,082	11	11,755	21	40,837	21	40,837	21	86,114	34	99,376		
Austrian	1	570	2	9,028	8	35,298	2	15,896	10	51,194	2	32,893	2	12,699	8	45,592		
Belgian	1	3,822	1	3,822	8	3,822	15	34,663	16	38,485	16	47,947	20	68,431	20	68,431		
Brazilian	111	526,585	10	30,158	121	556,743	813	5,132,278	214	1,172,968	1,027	6,305,246	921	5,700,740	1,201	7,284,594		
British	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Chilean	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Chinese	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Cuban	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Danish	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Danzig	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Dutch	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Egyptian	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Estonian	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
Finnish	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
French	1	2,230	1	612	2	2,842	4	17,155	2	2,044	5	18,665	1	2,044	6	20,710		
German	23	119,138	4	15,388	4	15,388	73	402,010	8	31,775	81	523,980	81	542,613	86	553,820		
Greek	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Guatemalan	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Honduran	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Italian	1	979	2	1,113	3	2,092	88	564,779	53	815,655	141	880,434	82	513,703	139	799,224		
Japanese	5	46,131	5	46,131	5	46,131	90	562,671	24	81,109	114	643,730	91	560,640	124	686,593		
Latvian	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Mexican	6	17,795	6	17,795	6	17,795	9	21,430	1	668	10	22,098	13	31,833	13	31,833		
Moroccan	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Nicaraguan	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Norwegian	5	31,675	2	2,878	7	33,953	96	495,796	130	516,522	226	1,002,318	102	514,358	257	1,200,852		
Panaman	5	18,192	5	18,192	5	18,192	8	24,856	3	9,078	11	32,435	2	8,069	13	35,783		
Peruvian	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Philippine	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Portuguese	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Romanian	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Russian	3	5,979	3	5,979	3	5,979	10	24,114	8	18,381	19	27,701	14	49,053	14	49,053		
Siamese	5	3,209	5	3,209	5	3,209	22	89,066	26	4,208	48	130,354	6	4,917	34	127,054		
Spanish	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Swedish	4	14,895	4	14,895	4	14,895	17	82,548	50	283,457	76	365,959	18	55,148	57	289,361		
Uruguayan	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Venezuelan	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Yugoslavian	1	597	1	597	1	597	1	597	1	597	1	597	1	597	1	597		
Total	144	1,527,728	60	194,019	501	1,721,747	3,373	17,980,414	881	3,674,426	4,254	21,654,840	3,558	18,741,884	1,009	4,572,171	4,567	23,314,055

^a Exclusive of Army, Navy, Admiralty, and other Government oil burners.

^b Including oil burners on Great Lakes.
Authority: All figures, except for American vessels, are prepared from Lloyd's Register.

opment before the war was over. New vessels as they came off the ways became oil burners and, when the war ended, the conversion was virtually complete. All the navies of the Great Powers are now on an oil burning basis. Of even more significance in its effect upon the petroleum and coal industries, the one favorably and the other unfavorably, was a similar conversion to an oil burning basis of the merchant shipping of the world.

Thus, before the war (1914) of the world's total gross tonnage (steam and gas) amounting to 45,404,000 tons, probably less than 4 per cent burned oil. In 1920, the world's tonnage had increased to 53,905,000 tons of which oil burners represented about 17 per cent. In 1928 the total tonnage was 65,159,000 tons, of which 23,314,000 tons, or 34 per cent, was listed as oil burners.

The American merchant marine has an oil burning tonnage of 9,318,000 gross tons, the largest of any country. In 1914, its oil burning tonnage amounted to only 656,000 gross tons. Great Britain has an oil burning tonnage of 7,285,000 gross tons, and in 1914 its total was approximately 557,000 gross tons.

GROWTH OF MOTOR SHIPS

The rapid growth of the motor or oil engine ship since the World War is revealed in the preceding tables showing a gross world tonnage in 1920 of 693,000 tons, as contrasted with the present tonnage of 4,572,000 tons. The world's mercantile marine is being rapidly Dieselized. (See "Utilization of Diesel Oil.")

About half the ships launched in the world in 1928 were automobiles of the sea; that is, their power was furnished by internal combustion engines similar in principle to the motor car.

MERCHANT VESSELS OF 100 GROSS TONS AND OVER (STEEL AND WOOD) LAUNCHED DURING THE YEAR ENDED DECEMBER 31, 1928

FACTS AND FIGURES

Year	Steam		Motor		Sail and barge		Total	
	No.	Gross	No.	Gross	No.	Gross	No.	Gross
1928.....	507	1,477,092	302	1,183,229	60	38,918	869	2,699,239
1927.....	480	1,375,828	254	863,694	68	46,157	802	2,285,679
1926.....	319	926,128	206	704,006	75	44,843	600	1,674,977
1925.....	544	1,298,696	198	843,629	113	51,079	855	2,193,404
1924.....	689	1,698,943	149	502,398	86	47,010	924	2,247,751
America—								
Atlantic and Gulf Coasts.....	7	28,346	15	24,849	30	24,805	52	78,000
Pacific Coast.....	1	3,092	..	..	4	5,000	5	8,092
Great Lakes.....	4	2,029	2	3,236	..	..	6	5,265
Total.....	12	33,467	17	28,085	34	29,805	63	91,357
Belgium.....	8	16,243	..	..	..	..	8	16,243
Brazil.....	..	..	1	770	..	..	1	770
China.....	2	767	..	..	..	..	2	767
Denmark.....	1	2,456	5	37,141	..	..	6	39,597
France.....	4	4,944	27	133,768	..	..	31	138,712
Germany.....	10	26,852	10	154,784	..	..	20	81,416
Italy.....	45	199,678	30	177,338	..	..	81	376,416
Japan.....	10	22,032	15	56,582	4	1,066	29	58,640
Netherlands.....	19	44,879	13	88,784	..	..	37	103,063
Norway.....	31	81,622	43	86,132	..	..	74	166,754
Russia.....	10	6,474	2	3,997	..	..	12	10,401
Spain.....	2	5,020	5	19,694	..	..	10	24,714
Sweden.....	2	504	..	..	..	..	7	11,852
Uruguay.....	5	3,275	15	103,637	..	..	20	106,912
Other countries.....	..	..	2	700	..	..	1	700
Great Britain and Ireland.....	..	..	..	299	..	..	4	712
British Dominions—								
Canada—	330	1,012,774	76	427,916	14	5,230	420	1,445,920
Coast.....	..	..	..	..	..	..	..	..
Great Lakes.....	3	7,287	15	2,802	6	2,414	24	12,503
Other.....	1	734	..	..	..	..	1	734
Total.....	17	9,094	6	362	..	..	23	9,456
World total.....	351	1,029,889	97	431,080	20	7,644	468	1,468,613
World total.....	507	1,477,092	302	1,183,229	60	38,918	869	2,699,239

^a This statement embraces vessels launched during the year without regard to the date of completion.

Authority : Lloyd's Register of Shipping.

WORLD CONSUMPTION OF GASOLINE

The United States consumes 297,483,000 barrels, or 76.2 per cent of the world's total consumption of gasoline, according to the best estimates available; and all of North America accounts for 310,565,000 barrels, or 79.54 per cent.

Among European countries, the United Kingdom is the largest consumer of gasoline, with a total of 21,125,000 barrels. Germany and France practically consume equal quantities, with 10,286,000 barrels for Germany and 10,174,000 barrels for France. European consumption amounts to 57,499,000 barrels, or 14.73 per cent of total world consumption. North America and Europe combined consume 94.27 per cent of the world total, leaving a balance of only 5.73 per cent for the remainder of the world.

These figures are for the year 1927, and are based on a cooperative publication of the Bureau of Foreign and Domestic Commerce and the American Petroleum Institute, entitled "International Trade in Petroleum and Its Products." In many cases, a conservative estimate of local refinery output, or the probable increases of 1927 gasoline imports over 1926, had to be made where official figures were not available. In certain countries—notably England, France, and Germany—benzol and gasoline from shale distillation have been included, since these are consumed in combination with gasoline.

It is interesting to note that, for the year 1927, the domestic gasoline consumption of the United States, plus gasoline exports of that year, accounted for 87.5 per cent of the world's estimated gasoline consumption.

ESTIMATED WORLD GASOLINE CONSUMPTION 1927
(In Thousands of Barrels of 42 U. S. Gallons.)

		Percentage World Consumption
NORTH AMERICA		
Canada	11,707	
Mexico	1,209	
United States	297,483	
Alaska	166	
Total	310,565	79.54%
CENTRAL AMERICA		
British Honduras	12	
Costa Rica	29	
Guatemala	35	
Honduras	12	
Nicaragua	17	
Panama	30	
Salvador	38	
Total	173	.04%
WEST INDIES		
Bahamas	15	
Barbados	16	
Cuba	1,127	
Dominican Republic	90	
Haiti	34	
Jamaica	88	
Martinique	8	
Trinidad	125	
Total	1,503	.39%
SOUTH AMERICA		
Argentina	2,874	
Bolivia	38	
Brazil	1,487	
British Guiana	19	
Chile	386	
Colombia	389	
Ecuador	46	
Paraguay	1	
Peru	280	
Uruguay	393	
Venezuela	189	
Total	6,102	1.56%

ESTIMATED WORLD GASOLINE CONSUMPTION 1927 (*Continued*)

		Percentage World Consumption
EUROPE		
Austria	611	
Belgium	1,177	
Bulgaria	54	
Cyprus	11	
Czechoslovakia	822	
Denmark	1,196	
Estonia	38	
Finland	415	
France	10,174	
Germany	10,286	
Greece	244	
Hungary	268	
Irish Free State.....	552	
Italy	2,328	
Latvia	41	
Lithuania	33	
Malta	18	
Netherlands	1,358	
Norway	404	
Poland	432	
Portugal	249	
Roumania	752	
Russia	694	
Spain	1,733	
Sweden	1,472	
Switzerland	814	
Turkey	4	
United Kingdom	21,125	
Yugoslavia	194	
Total	57,499	14.73%
AFRICA		
Algeria	430	
Angola	28	
Belgian Congo	109	
Egypt	287	
Eritrea	3	
Abyssinia	2	
French Morocco	292	
Gambia	1	
Gold Coast	138	
It. Somaliland	1	
Kenya & Uguanda.....	100	
Madagascar	17	

ESTIMATED WORLD GASOLINE CONSUMPTION 1927 (*Continued*)

		Percentage World Consumption
<i>AFRICA—Continued</i>		
Mauritius	27	
Mozambique	14	
Nigeria	93	
Northern Rhodesia	8	
Portuguese Guinea	3	
Sierra Leone	4	
Southern Rhodesia	64	
South West Africa.....	33	
Sudan	39	
Tanganyika	30	
Tripoli	17	
Tunis	113	
Union of South Africa.....	1,079	
Zanzibar	5	
Total	2,937	.75%
<i>ASIA</i>		
Aden	7	
Sarawak	2	
British India	1,347	
British Malaya	502	
Ceylon	206	
China	314	
Korea	56	
French Indo China.....	166	
Irak	48	
Japan	1,500	
Netherlands East Indies.....	225	
Palestine	46	
Persia	500	
Philippine Islands	339	
Siam	111	
Syria	60	
Total	5,429	1.39%
<i>AUSTRALIA AND NEW ZEALAND</i>		
Australia	4,861	
New Zealand	1,372	
Total	6,233	1.60%
World Total	390,441	100.00%

AMERICAN PARTICIPATION IN FOREIGN MARKETS

Crude oil supplies which are developed in remote countries, to be marketable, must find their way to refineries and be converted into saleable products. The United States, in the development of its own petroleum resources, has, as stated, built up a great refining industry. Its facilities for manufacturing the products which are in demand have attracted, and will continue to attract, foreign raw material, and its position in supplying the world with petroleum products will remain important, until such time as foreign production and refining facilities are far more extensively developed than they are at present.

For these reasons, imports of oil into the United States do not indicate with any exactitude the barrelage extent of America's actual dependency upon foreign oil. Most of the oil imported is of heavy quality, suitable for use chiefly as fuel oil, and much of it goes into marine use. Some is "topped" or refined, however, and, with modern refining methods, an increasing gasoline recovery is being obtained.

U. S. PETROLEUM PRODUCTION AND IMPORTS

Year	U. S. production Barrels	Imports *
1918.....	355,928,000	38,943,000
1919.....	378,367,000	54,161,000
1920.....	442,929,000	108,794,000
1921.....	472,183,000	128,776,000
1922.....	557,531,000	135,947,000
1923.....	732,407,000	99,608,000
1924.....	713,940,000	94,534,000
1925.....	763,743,000	78,149,000
1926.....	770,874,000	81,281,000
1927.....	901,129,000	71,664,000
1928.....	902,000,000	91,567,000

* All oil.

Authorities: U. S. Bureau of Mines and U. S. Bureau of Foreign and Domestic Commerce.

EXPORTS OF PETROLEUM

Total exports of domestic merchandise from the United States in 1928, according to the U. S. Bureau of Foreign and Domestic Commerce, were \$5,029,682,000, of which crude petroleum and petroleum products contributed \$525,537,000, or 10 per cent. The value of exports of crude petroleum and petroleum products in that year is shown in the following table:

Crude oil	\$26,786,000
Refined products	498,751,000
	\$525,537,000

The value of refined petroleum products in the same year, segregated by principal products, is shown in the following table:

Gasoline	\$231,969,946
Kerosene	93,477,916
Gas and fuel oil.....	45,797,151
Lubricating oil	91,591,415

Crude oil and each of its refined products are subject in export, as well as in domestic, commerce to distinctly different trade factors, the various products, although they come from a common source, being almost totally different as regards factors of supply and demand. Exports of crude oil are negligible as compared with total domestic production and imports. The bulk of the outgoing crude oil goes across the border by pipe line to supply Canadian refineries. The exportation of kerosene and lubricating oils consumes a considerable proportion of the total of both domestic production and imports. The exportation of gasoline and of gas oil and fuel oil is relatively small.

The relation of exports to total supply is shown in the following table:

RELATION OF PETROLEUM EXPORTED TO U. S. PRODUCTION AND IMPORTS, IN 1928

	U. S. production and imports *	Exports Barrels	Per cent Exports
Crude Oil	981,583,000	18,964,000	1.9
Gasoline	381,480,000	53,803,000	14.1
Kerosene	60,359,000	22,066,000	36.6
Gas and fuel oil.....	433,023,000	44,457,000	10.3
Lubricating oil	34,672,000	10,957,000	31.3

* Production of refined products embraces total output of U. S. refineries from both domestic and foreign crude oil.

EXPORTS OF PETROLEUM AND PRODUCTS FROM UNITED STATES
(Thousands of Barrels of 42 U. S. Gallons)

Year	Crude oil	Refined products	Total
1913.....	5,407	46,238	51,645
1918.....	5,884	61,172	67,056
1919.....	6,253	56,505	62,758
1920.....	8,583	68,696	77,279
1921.....	9,552	60,763	70,315
1922.....	10,637	62,065	72,702
1923.....	17,210	82,848	100,058
1924.....	17,879	97,328	115,207
1925.....	13,155	98,592	111,747
1926.....	15,477	113,552	129,029
1927.....	15,843	115,399	131,242
1928.....	18,961	126,187	145,148

Authority: U. S. Bureau of Foreign and Domestic Commerce.

VALUE OF EXPORTS OF PETROLEUM AND PRODUCTS FROM THE UNITED STATES
(Thousands of Dollars)

Year	Crude oil	Refined products	Total
1913.....	\$9,052	\$140,868	\$149,920
1918.....	13,474	338,151	351,625
1919.....	15,359	338,391	353,750
1920.....	30,078	532,499	562,577
1921.....	21,598	376,108	397,706
1922.....	19,410	321,424	340,834
1923.....	23,287	338,061	361,348
1924.....	26,772	403,019	429,791
1925.....	24,282	435,739	460,021
1926.....	28,499	510,978	539,477
1927.....	25,944	429,663	455,607
1928.....	26,786	464,899	491,685

Authority: U. S. Bureau of Foreign and Domestic Commerce.

EXPORTS OF REFINED PETROLEUM PRODUCTS FROM THE UNITED STATES
(Thousands of Barrels of 42 U. S. Gallons)

Year	Gasoline	Kerosene	Gas and fuel oil	Lubricating oil
1913.....	4,639	27,056	10,164	4,983
1918.....	13,545	11,820	29,642	6,165
1919.....	9,098	23,537	17,273	6,598
1920.....	15,637	20,881	22,538	9,643
1921.....	13,171	17,997	22,955	6,975
1922.....	14,157	21,489	18,479	7,940
1923.....	20,736	20,349	33,372	8,370
1924.....	28,967	21,961	37,248	9,104
1925.....	31,491	21,212	36,071	9,689
1926.....	43,852	21,789	38,347	9,346
1927.....	43,334	19,352	42,963	9,606
1928.....	51,757	21,853	41,558	10,850

Authority: U. S. Bureau of Foreign and Domestic Commerce.

VALUE OF EXPORTS OF REFINED PETROLEUM PRODUCTS FROM THE UNITED STATES
(Thousands of Dollars)

Year	Gasoline	Kerosene	Gas and fuel oil	Lubricating oil
1913.....	\$29,263	\$73,748	\$11,126	\$30,041
1918.....	87,452	51,107	68,912	76,297
1919.....	64,354	120,564	35,291	86,058
1920.....	109,218	134,621	60,011	157,062
1921.....	135,585	95,293	51,426	93,803
1922.....	130,478	84,328	28,949	77,669
1923.....	142,034	77,706	40,223	77,891
1924.....	171,872	89,629	53,199	88,001
1925.....	202,673	85,657	54,135	92,521
1926.....	268,924	101,039	49,763	88,432
1927.....	209,839	79,303	49,802	88,843
1928.....	231,970	93,478	45,797	91,591

Authority: U. S. Bureau of Foreign and Domestic Commerce.

CRUDE PETROLEUM EXPORTS FROM THE UNITED STATES
(Barrels of 42 U. S. Gallons)

Destination	1928	1927
Europe	556,421	416,721
Canada	15,431,230	13,036,216
Cuba	527,956	526,819
Japan	2,066,139	1,633,389
Other Countries	379,616	230,260
Total	18,961,362	15,843,405

Authority: U. S. Bureau of Foreign and Domestic Commerce.

GASOLINE EXPORTS
(Barrels of 42 U. S. Gallons)

Destination	1928	1927
Europe	33,488,832	29,493,978
North, Central and South America....	9,493,434	6,965,678
Far East, Australia.....	5,331,453	4,501,322
Africa	2,287,325	1,723,713
Other Countries	1,155,489	649,473
Total	51,756,533	43,334,164

GASOLINE EXPORTS FROM THE UNITED STATES BY COUNTRIES
(Barrels of 42 U. S. Gallons)

To	1928	1927
Belgium	1,273,745	1,126,085
Denmark	970,271	1,099,945
France	7,726,261	6,832,669
Germany	1,318,250	1,230,997
Irish Free State.....	170,753	172,674
Italy	1,464,690	982,721
Netherlands	1,884,855	1,674,054
Norway	287,155	282,797
Portugal	223,558	184,323
Spain	967,001	984,202
Sweden	1,561,523	1,232,641
United Kingdom	15,640,770	13,690,870
Canada	4,409,565	3,144,539
Panama	180,143	96,548
Mexico	300,430	364,465
Cuba	809,224	488,867
Dominican Republic	86,731	72,189
Argentina	1,782,798	1,349,996
Brazil	1,254,131	942,660
Uruguay	405,875	353,355
Other South America.....	264,537	153,059
China, Hong Kong.....	244,581	321,155
Japan	737,723	356,044
Philippine Islands	377,428	292,704
Australia	2,751,815	2,470,403
New Zealand	1,219,906	1,061,016
British South Africa.....	931,603	657,976
British West Africa.....	348,512	284,940
French Africa	700,854	558,302
Morocco	134,242	83,004
Portuguese Africa	94,831	84,500
Spanish Africa	77,283	54,991
Other Countries	1,155,489	649,473
Total	51,756,533	43,334,164
In bulk	47,288,881	38,745,589
In containers	4,467,652	4,588,575

Authority: U. S. Bureau of Foreign and Domestic Commerce.

KEROSENE EXPORTS

Destination	1928	1927
Europe	9,596,822	9,507,496
North, Central and South America.....	1,394,443	1,624,059
Far East, Australia.....	9,413,533	6,894,767
Africa	1,054,359	999,498
Other Countries	393,469	326,282
Total	21,852,626	19,352,102

KEROSENE EXPORTS FROM THE UNITED STATES BY COUNTRIES

(Barrels of 42 U. S. Gallons)

To	1928	1927
Belgium	296,373	538,588
Denmark	526,492	517,990
France	1,669,660	1,127,435
Germany	838,610	832,922
Italy	160,039	258,492
Netherlands	1,599,226	1,757,326
Norway	262,775	269,935
Portugal	356,192	315,948
Spain	101,824	77,623
Sweden	460,700	284,978
United Kingdom	2,944,533	3,172,465
Other Europe	380,398	353,794
Canada	150,058	128,003
Central America	45,142	78,412
West Indies, Bermudas.....	178,769	159,191
Argentina	189,773	336,200
Brazil	649,969	696,843
Uruguay	180,732	225,410
British India	474,827	1,360,741
British Malaya	12,391	153,404
China, Hong Kong.....	4,769,165	2,618,322
Dutch East Indies.....	174,162	186,763
French Indo China.....	75,763	54,683
Japan	2,371,610	1,608,997
Philippine Islands	360,405	197,460
Australia	998,344	599,604
New Zealand	176,866	114,793
British Africa	669,191	608,364
French Africa	283,884	320,211
Portuguese Africa	101,284	70,923
Other Countries	393,469	326,282
Total	21,852,626	19,352,102
In bulk	16,290,641	13,832,317
In containers	5,561,985	5,519,785

Authority: U. S. Bureau of Foreign and Domestic Commerce.

GAS AND FUEL OIL EXPORTS

(Barrels of 42 U. S. Gallons)

Destination	1928	1927
Europe	9,499,805	9,473,312
North, Central and South America.....	21,719,490	24,755,189
Far East and Australia.....	7,785,994	7,182,808
Africa	79,044	71,996
Other Countries	2,474,034	1,479,875
Total	41,558,367	42,963,180

GAS AND FUEL OIL EXPORTS FROM THE UNITED STATES BY COUNTRIES
(Barrels of 42 U. S. Gallons)

To	1928	1927
Belgium	433,935	534,410
Denmark	597,528	717,649
France	578,477	92,553
Germany	1,793,140	1,257,971
Italy	402,800	182,308
Netherlands	884,301	769,653
Norway	106,747	106,004
Spain	153,242	68,511
Sweden	146,894	236,970
United Kingdom	4,402,741	5,507,283
Canada	2,371,833	2,377,177
Panama	5,188,569	7,360,016
Mexico	1,218,770	1,042,743
Cuba	2,025,707	1,942,493
Other West Indies and Bermudas.....	604,037	544,549
Argentina	2,113,870	4,307,750
Brazil	887,428	1,232,879
Chile	6,328,693	4,349,940
Other South America.....	980,583	1,597,642
China, Hong Kong.....	1,131,086	1,159,120
Japan	5,114,192	4,419,106
Philippine Islands	592,431	685,995
New Zealand	948,285	918,587
French Africa	79,044	71,996
Other Countries	2,474,034	1,479,875
Total	41,558,367	42,963,180
Fuel or bunker oil for vessels in foreign trade, not included in above:		
On American vessels.....	23,263,915	22,205,735
On foreign vessels.....	27,860,905	27,844,839
Total	51,124,820	50,050,574

Authority: U. S. Bureau of Foreign and Domestic Commerce.

LUBRICATING OIL EXPORTS FROM THE UNITED STATES BY COUNTRIES
(Barrels of 42 U. S. Gallons)

	1928	1927
Red and Pale Lubes		
To		
Belgium.....	757,913	645,338
Denmark.....	107,281	112,715
France.....	1,008,851	792,593
Germany.....	859,190	777,802
Italy.....	263,414	155,777
Netherlands.....	208,474	96,266
Spain.....	54,483	143,738
Sweden.....	98,983	58,908
United Kingdom.....	1,320,965	1,199,515
Other Europe.....	87,589	107,279
Canada.....	303,436	250,945
Mexico.....	47,525	46,071
Cuba.....	47,110	59,264
Argentina.....	125,442	193,615
Brazil.....	149,441	141,938
Chile.....	37,741	36,198
Other South America.....	70,864	58,881
British India.....	388,682	300,061
China, Hong Kong, and Kwantung.....	254,485	145,230
Netherland East Indies.....	39,156	51,371
Japan.....	198,870	186,432
Philippine Islands.....	70,354	44,019
Australia.....	183,963	171,288
New Zealand.....	42,798	37,224
British Africa.....	33,116	29,426
Egypt.....	38,507	14,588
Portuguese Africa.....	14,266	10,674
Other countries.....	126,172	116,982
Total Red and Pale.....	6,939,071	5,984,138
Black		
Cylinder	1,029,270	671,776
To		
Belgium.....	118,209	100,440
Denmark.....	12,120	21,890
France.....	391,272	335,936
Germany.....	438,402	331,720
Italy.....	213,086	196,454
Netherlands.....	74,102	76,011
Norway.....	6,367	9,918
Spain.....	31,506	51,662
Sweden.....	20,737	22,485
United Kingdom.....	551,931	753,754
Canada.....	153,706	107,271
Mexico.....	34,581	22,240
Cuba.....	29,899	30,388
Argentina.....	85,965	110,194
Brazil.....	92,828	55,794
Chile.....	19,506	17,679
Other South America.....	40,106	40,139
British India.....	43,379	67,429
China, Hong Kong, and Kwantung.....	17,953	23,077
Netherland East Indies.....	10,299	8,621
Japan.....	48,832	56,361
Philippine Islands.....	1,740	2,788
Australia.....	143,927	180,884
New Zealand.....	30,676	33,995
British Africa.....	74,850	85,215
Egypt.....	43,082	46,664
Portuguese Africa.....	29,349	29,258
Other countries.....	122,790	131,576
Total Cylinder.....	2,881,200	2,949,843
Total Lubricating Oil.....	10,849,541	9,605,757
Mineral spirits (substitute for turpentine).....	Gal. 2,352,727	2,648,274
Insulating or transformer oils.....	Gal. 4,232,854	2,844,976
Light lubricating oils in small packages.....	Gal. 544,925	540,360
Lubricating greases.....	Lb. 108,111,834	100,483,272
Paraffin wax.....	Lb. 392,648,443	340,422,834
Petroleum asphalt.....	Ton. 442,129	343,778
Petroleum coke.....	Ton. 128,688	93,253
Petroleum residuum.....	Bbl. 62,506	217,239

Authority: U. S. Bureau of Foreign and Domestic Commerce.

THE PETROLEUM INDUSTRY OF THE UNITED STATES

RECENT ECONOMIC CHANGES

The petroleum industry is strikingly important in its relation to modern life. It occupies, by force of the essential quality of its products, a position of outstanding significance to general prosperity. It is closely related to all industry and to the everyday life of the individual.

If the revolutionary industrial changes of recent years have been in speed and spread, rather than in fundamental structure, as the Committee on Recent Economic Changes of the President's Conference on Unemployment * believes, the oil industry reflects the impulse of the times to a notable extent.

"Each generation," says the committee, "believes itself to be on the verge of a new economic era, an era of fundamental change, but the longer the committee deliberated, the more evident it became that the novelty of the period covered by the present survey (1922 to 1929) rested chiefly in the fact that developments such as formerly affected our old industries have been recurring in our new industries. The changes have not been in structure but in speed and spread.

"Invention is not a new art. Transportation and communication are not new services. The facilitating function of finance is older than coined currency. Agriculture is as ancient as history. Competition is not a new phenomenon. None of the changes in distribution on which emphasis has been laid in the last few years is basically new. Hand-to-mouth buying is old; sudden changes in style and demand are familiar; there is no new principle in installment selling; cooperative marketing is no modern discovery; the chain-store movement dates back at least 25 years. But the breadth and scale and 'tempo' of recent developments give them new importance.

* Complete report is published by the McGraw-Hill Book Co., New York.

“ The increased supply of power and its wider uses; the multiplication by man of his strength and skill through machinery, the expert division and arrangement of work in mines and factories, on the farms and in the trades, so that production per man-hour of effort has risen to new heights; the quickening of these instrumentalities through capital provided from the surplus incomes of a constantly widening proportion of our people—all these represent an accumulation of forces which have long been at work.

“ The committee, like other observers, was early impressed by the degree of economic activity in these seven years. It was struck by the outpouring of energy which piled up skyscrapers in scores of cities; knit the 48 states together with 20,000 miles of airways; moved each year over railways and waterways more than a billion and a half tons of freight; thronged the highways with 25,000,000 motor cars; carried electricity to 17,000,000 homes; sent each year 3,750,000 children to high school and more than 1,000,000 young men and women to college; and fed, clothed, housed, and amused the 120,000,000 persons who occupy our twentieth of the habitable area of the earth. . . .

“ While industrial, agricultural, and commercial activity has been ‘ spotty,’ the broad social advantages of our accelerated activity flowed out over the land. For example, the highway-building programs throughout the nation were not limited to the intensely active areas; good roads were extended in all directions, serving the whole population. The same might be said for educational advantages, radio entertainment, personal mobility made possible by low-priced motor cars, swift and dependable transportation and communication, and numerous other facilities and services making for comfort and well-being, beyond the elemental requirements of food, clothing, and shelter.

“ This spread of higher living standards has been characteristic of our national life practically throughout our history. As a phenomenon it is not new, but in its degree and scope it has taken on a new importance.”

GROWTH OF THE PETROLEUM INDUSTRY *

SCOPE OF PETROLEUM INDUSTRY

More states in the United States have a significant share in the petroleum industry than there are cotton states or wheat states, or corn states, or steel states, or textile states.

Nineteen states now produce petroleum. The refining of petroleum has spread to twenty-nine states.

STATES WHERE PETROLEUM IS PRODUCED AND REFINED

	Production 1928		Rated refinery capacity January 1, 1929	
	Barrels	Per cent of total	Barrels per day	Per cent of total
Arizona .....	.....	....	900	.03
Arkansas	32,295,000	3.59	35,000	1.05
California	231,982,000	25.76	841,460	25.30
Colorado	2,722,000	.30	3,350	.10
Georgia .....	.....	....	5,000	.15
Illinois	6,459,000	.72	106,300	3.20
Indiana	1,053,000	.12	147,500	4.44
Kansas	38,332,000	4.26	126,500	3.80
Kentucky	7,325,000	.81	18,200	.55
Louisiana	21,626,000	2.40	216,830	6.52
Maryland .....	.....	....	40,000	1.20
Massachusetts .....	.....	....	70,000	2.11
Michigan	595,000	.06	1,500	.04
Missouri .....	.....	....	14,500	.44
Montana	3,925,000	.44	17,500	.52
New Jersey .....	.....	....	291,000	8.75
New Mexico	959,000	.11	3,450	.10
New York	2,573,000	.29	34,500	1.04
Ohio	7,030,000	.78	68,050	2.05
Oklahoma	249,558,000	27.72	274,700	8.26
Pennsylvania	9,876,000	1.10	203,650	6.12
Rhode Island .....	.....	....	11,200	.34
South Carolina .....	.....	....	15,000	.45
Tennessee	47,000	....	500	.01
Texas	256,888,000	28.53	658,100	19.79
Utah .....	.....	....	4,500	.13
Virginia .....	.....	....	1,500	.04
West Virginia	5,704,000	.63	14,500	.44
Wyoming	21,415,000	2.38	100,700	3.03
Totals	900,364,000	100.00	3,325,890	100.00

* For "Growth and Competition in the Petroleum Industry," see also "Petroleum Facts and Figures," first edition, p. 82.

PETROLEUM LEADS IN GAINS OF MINERALS

Of all the mineral industries, the production of petroleum shows the greatest gains in recent years. According to a compilation made by the U. S. Department of Commerce (with 1923-1925 average as the basis), the index of production of petroleum in 1928 showed a gain of 22 per cent, with copper production showing the next largest gain of 15 per cent, and zinc a gain of 12 per cent. The average of all minerals showed an increase of 6 per cent.

This table also shows that production of oil increased 135 per cent since 1919.

INDEX OF PRODUCTION OF MINERALS, BY PRODUCTS
[Adjusted for seasonal variations. 1923-1925 average = 100]

Annual indexes	All minerals	Bituminous coal	Anthracite coal	Crude petroleum	Iron ore shipments	Copper	Zinc	Lead	Silver
1919.....	77	88	109	52	88	77	.....	.....	.....
1920.....	89	108	110	61	114	80	87	.....	.....
1921.....	70	79	112	64	40	30	39	66	84
1922.....	74	80	69	76	80	63	68	77	87
1923.....	105	108	115	100	114	93	96	88	102
1924.....	96	92	108	97	82	100	97	102	100
1925.....	99	100	77	103	104	106	107	111	98
1926.....	108	110	105	104	113	110	116	114	95
1927.....	107	99	99	121	95	105	111	112	93
1928.....	106	94	95	122	104	115	112	106	88

Authority: Department of Commerce, Survey of Current Business.

OIL PRODUCTS SET THE PRODUCTION PACE

Among the principal manufactured commodities, according to the U. S. Department of Commerce, the production of petroleum products shows the largest gain in 1928, with an increase of 52 per cent over the average production computed for the years 1923-1925. Rubber tires showed the next largest increase of 44 per cent; while the allied automobile industry showed an increase of 13 per cent.

INDEX OF PRODUCTION OF MANUFACTURES, BY GROUPS
[Adjusted for seasonal variations, 1923-1925 average = 100]

Annual indexes	All manu- factures	Iron and steel	Textiles	Food products	Paper and printing	Lumber	Automobiles	Leather and shoes	Cement, brick, and glass	Non-ferrous metals	Petroleum refining	Rubber tires	Tobacco manu- factures
1919.....	84	82	92	93	76	79	53	104	53	67	54	...	83
1920.....	86	99	84	84	86	79	55	95	68	78	63	...	86
1921.....	66	46	88	84	66	68	41	91	62	39	64	55	85
1922.....	87	83	99	94	85	89	66	103	78	69	74	78	88
1923.....	101	105	105	99	95	99	102	110	95	94	86	86	96
1924.....	94	88	91	103	99	96	90	94	95	99	99	98	99
1925.....	105	106	104	98	106	105	107	96	110	107	115	116	105
1926.....	108	113	104	97	115	100	111	98	113	112	125	116	112
1927.....	106	104	113	96	113	94	89	103	109	109	136	120	118
1928.....	111	119	107	98	117	89	113	102	120	115	152	144	124

Authority: Department of Commerce, Survey of Current Business.

PETROLEUM REFINING FIFTH IN VALUE OF MANUFACTURES

The petroleum refining industry, according to the Census of Manufactures, ranked fifth in the value of products manufactured in 1927. The wholesale value of petroleum products in that year was \$2,142,648,503. The industry of slaughtering and meat packing led with a wholesale value of \$3,057,215,718; and motor vehicle manufacture ranked second, with a wholesale value of vehicles of \$2,848,442,843.

WHOLESALE VALUE OF MANUFACTURES

	Wholesale value 1927
1. Slaughtering and meat packing.....	\$3,057,215,718
2. Motor vehicles, not including motorcycles.....	2,848,442,843
3. Iron and steel: steel works and rolling mills	2,779,840,238
4. Foundry and machine-shop products, not elsewhere classified.	2,259,794,443
5. Petroleum refining	2,142,648,503
6. Electrical machinery, apparatus, and supplies.....	1,637,307,035
7. Printing and publishing, newspaper and periodical.....	1,577,866,988
8. Cotton goods	1,567,400,612
9. Clothing, women's, not elsewhere classified.....	1,494,401,044
10. Bread and other bakery products.....	1,378,629,764

Authority: Census of Manufactures, 1927.

CENSUS OF PETROLEUM REFINING, 1927

The U. S. Department of Commerce, in its biennial census of manufactures taken in 1928, reports that establishments engaged primarily in petroleum refining in 1927 showed products valued at \$2,142,648,503, a decrease of 9.8 per cent as compared with \$2,376,656,556 for 1925, the last preceding census year.

SUMMARY FOR PETROLEUM REFINING INDUSTRY, 1927 AND 1925

	1927	1925	Per cent of increase or decrease (—)
Number of establishments.....	354	359	— 1.4
Wage earners (average for the year)*	71,234	65,324	9.0
Wages †	\$113,716,705	\$104,645,391	8.7
Cost of materials, supplies, containers for products, fuel, and purchased power, total †.....	\$1,752,997,043	\$1,889,678,019	— 7.2
Materials, supplies, and containers	\$1,649,288,320	‡	.....
Fuel and power.....	\$103,708,723	‡	.....
Products, total value †.....	\$2,142,648,503	\$2,376,656,556	— 9.8
Petroleum products and by-products, value	\$2,133,922,688	\$2,364,069,067	— 9.7
Other products, value.....	\$8,725,815	\$12,587,489	— 30.7
Value added by manufacture §....	\$389,651,460	\$486,978,537	— 20.0
Horsepower	552,651	393,753	40.4

* Not including salaried employees.

† The amount of manufacturers' profits cannot be calculated from the census figures, for the reason that no data are collected in regard to a number of items of expense, such as interest on investment, rent, depreciation, taxes, insurance, and advertising.

‡ Not reported separately.

§ Value of products less cost of materials, supplies, containers for products, fuel, and purchased power.

VALUE OF PETROLEUM PRODUCTS, 1927 AND 1925

	1927	1925
Gasoline and other light products of distillation.	\$1,102,154,007	\$1,265,284,305
Illuminating oils	147,925,073	161,880,676
Fuel oils, distillates and gas oils, etc.....	456,959,052	488,957,806
Partially refined oils sold for rerunning	62,210,130	65,305,061
Lubricating oils	244,629,175	252,104,578
Liquid asphaltic road oils.....	9,307,838	12,511,739
Residuum or tar.....	5,117,722	5,581,753
Greases, including petrolatum, etc.....	12,961,205	13,920,627
Paraffin wax	23,432,260	30,590,464
Acid oil	1,848,797	1,139,310
Asphalt, other than liquid asphalt.....	37,884,108	30,460,927
Coke (petroleum)	7,169,596	6,437,483
Other refinery products*.....	22,323,725	29,894,338
Aggregate value	\$2,133,922,688	\$2,364,069,067

* Oils in process, still gas, wax tailings, etc.

OWNERSHIP OF OIL LANDS

The Federal Oil Conservation Board states that the producing and proven area of oil lands "in the United States is asserted to be in excess of 3,000,000 acres." * In addition to holdings of proven oil lands, companies reporting to the Federal Trade Commission showed holdings of over 22,000,000 acres of unproven oil lands.†

There are approximately 7,000 separate companies, partnerships, and individuals producing oil and reporting production and runs of oil through pipe lines to the U. S. Bureau of Mines.

The great bulk of the oil lands held by producing companies is leased from the land owner on a royalty basis. A one-eighth royalty is the most common portion. No accurate figure is available showing the number of royalty owners (farmers, land owners, investors, etc.) who share in the business of oil production. A one-eighth interest in

* Report of Federal Oil Conservation Board, Part I.

† Federal Trade Commission Report on Petroleum Industry, "Prices, Profits, and Competition," Dec. 12, 1927.

the total value of crude oil produced in the United States in 1928 would amount to \$135,055,000, indicative of the annual income of the oil royalty owners.

The royalty interest of the farmer or land owner is not by any means the only income he receives from petroleum operations. Rentals paid on leases by oil companies, as well as bonuses frequently paid for leases, run into hundreds of millions of dollars annually.

Bonuses paid on leases in the Osage Indian Reservation alone have totaled over a period of 16 years \$108,000,000; while royalty payments on oil, gas, and gasoline have netted the Indians in 27 years \$113,000,000.

PRODUCTION AND VALUE OF CRUDE OIL IN THE UNITED STATES

	(Thousands of Barrels)	(Value)
1916.....	300,767	\$330,900
1917.....	335,316	522,635
1918.....	355,928	703,944
1919.....	378,367	760,266
1920.....	442,929	1,360,745
1921.....	472,183	814,745
1922.....	557,531	895,111
1923.....	732,407	978,430
1924.....	713,940	1,022,683
1925.....	763,743	1,284,960
1926.....	770,874	1,447,760
1927.....	901,129	1,171,468
1928.....	†900,364	†1,080,437

† Preliminary estimate.

PETROLEUM USED AS POWER ON FARMS

The sources of power now available on farms in the United States, in addition to human labor, are animals; gas engines, including tractors, trucks, and automobiles; steam engines; and electric, wind, and water motors. All these sources draw on petroleum for lubrication. Stationary engines, tractors, trucks, and automobiles draw on the petroleum industry for gasoline and kerosene.

MOTOR VEHICLES ON FARMS, DECEMBER 31, 1928

States	Auto-mobiles	Motor trucks	All motor vehicles	States	Auto-mobiles	Motor trucks	All motor vehicles
Texas.....	327,000	35,600	362,600	Oregon.....	59,000	7,500	66,500
Ohio.....	219,500	39,500	259,000	West Virginia.....	58,000	7,000	65,000
Illinois.....	227,000	31,000	258,000	Louisiana.....	52,500	9,700	62,200
Iowa.....	225,000	25,400	250,400	Maryland.....	50,000	9,500	59,500
Pennsylvania.....	198,000	39,000	237,000	Idaho.....	56,000	2,700	58,700
Wisconsin.....	198,500	32,000	230,500	Florida.....	41,000	13,500	54,500
New York.....	182,500	40,500	223,000	New Jersey.....	31,500	11,400	42,900
Minnesota.....	193,000	26,500	219,500	Massachusetts.....	29,200	12,000	41,200
Missouri.....	191,000	21,900	212,900	Maine.....	31,000	6,600	37,600
Indiana.....	181,000	26,600	207,600	Connecticut.....	19,500	6,000	25,500
Michigan.....	176,500	19,600	196,100	Utah.....	21,000	3,000	24,000
Kansas.....	176,000	19,800	195,800	Vermont.....	20,300	3,600	23,900
California.....	155,000	25,000	180,000	Wyoming.....	19,000	2,800	21,800
Oklahoma.....	160,500	16,000	176,500	New Hampshire.....	17,000	4,600	21,600
Nebraska.....	148,000	18,000	166,000	Arizona.....	12,500	3,600	16,100
North Carolina.....	131,500	23,100	154,600	Delaware.....	9,500	3,200	12,700
Virginia.....	110,000	22,000	132,000	Nevada.....	5,000	1,000	6,000
Georgia.....	102,500	13,900	116,400	Rhode Island.....	4,300	1,000	5,300
Kentucky.....	102,500	10,300	112,800				
Alabama.....	92,500	12,500	105,000	United States			
South Dakota.....	87,500	9,500	97,000	1928.....	4,729,600	697,300	5,426,900
Mississippi.....	79,000	14,500	93,500	1927.....	4,408,470	598,654	5,007,124
Tennessee.....	84,500	8,100	92,600	1926.....	4,028,040	499,782	4,528,442
North Dakota.....	81,000	9,300	90,300	1925.....	3,853,526	478,956	4,332,482
Washington.....	73,000	13,500	86,500	1924.....	3,453,159	367,926	3,821,085
Arkansas.....	79,000	7,400	86,400	1923.....	3,289,630	285,250	3,574,880
South Carolina.....	72,500	7,300	79,800	1922.....	3,146,860	266,140	3,413,000
Montana.....	64,000	8,500	72,500	* 1919.....	2,146,512	139,169	2,285,681
Colorado.....	57,800	9,600	67,400				

* From U. S. Department of Agriculture.

TRACTORS ON THE FARM, DECEMBER 31, 1928

State	Tractors	State	Tractors
Texas.....	30,425	Arkansas.....	5,258
Ohio.....	48,302	South Carolina.....	4,481
Illinois.....	60,848	Montana.....	8,918
Iowa.....	54,665	Colorado.....	9,356
Pennsylvania.....	32,156	Oregon.....	8,568
Wisconsin.....	48,737	West Virginia.....	3,110
New York.....	41,795	Louisiana.....	4,841
Minnesota.....	38,757	Maryland.....	6,433
Missouri.....	18,352	Idaho.....	2,665
Indiana.....	35,439	Florida.....	5,019
Michigan.....	32,786	New Jersey.....	7,119
Kansas.....	47,466	Massachusetts.....	3,936
California.....	45,307	Maine.....	2,935
Oklahoma.....	18,976	Connecticut.....	2,493
Nebraska.....	28,159	Utah.....	1,245
North Carolina.....	14,394	Vermont.....	2,797
Virginia.....	11,188	Wyoming.....	1,849
Georgia.....	6,304	New Hampshire.....	988
Kentucky.....	7,847	New Mexico.....	1,667
Alabama.....	4,078	Arizona.....	1,734
South Dakota.....	25,209	Delaware.....	1,200
Mississippi.....	3,051	Nevada.....	294
Tennessee.....	7,785	Rhode Island.....	614
North Dakota.....	25,294		
Washington.....	6,441	United States.....	781,281

Authority: *The Farm Journal*

The following information is from U. S. Department of Agriculture Bulletin No. 1348, February, 1926:

“ The power of animals was the earliest form of power to be utilized by man, and up to about 60 years ago this source afforded practically the only power used by agriculture in the United States. Wind had been used to some extent, but the areas where windmills are most efficient were not settled before 1860; stationary steam engines were employed for operating threshing machines and other heavy belt work soon after the Civil War; and the gas engine came into successful use about the beginning of the twentieth century. From that time there has been a continuous and rapid development in the use of mechanical power in agriculture. Tractors were first used for draft work when a demand developed for large power units for grain farming in the West. Steam tractors were first used for this purpose but soon were displaced by the more practical gas tractors.

“ The small gas tractor, the truck, the automobile, and the use of electric power have been of more recent development and have only become important factors in agriculture during the last 10 or 12 years.

“ The automobile as a source of power on farms has not been considered, as only a small part of the power developed by this means is used to do actual farm work. Surveys that have been made would indicate that at least 80 per cent of the use the farmer makes of the automobile is in the care and supervision of his business.

“ Approximately 16,000,000,000 horsepower-hours are utilized annually at the present time. Of this amount animal power furnishes about 61 per cent, tractors 16 per cent, motor trucks slightly less than 4 per cent, stationary engines 12½ per cent, windmills slightly over 1 per cent, and electric power 5½ per cent.

“ Of the power developed, about 48 per cent is utilized for field work, 15 per cent for road hauling, 7 per cent for hauling about the farm, 17 per cent for heavy stationary work, and 13 per cent for light stationary work. (Heavy stationary work is considered as all operations requiring more than 5 horsepower.)

“ Plowing and listing, grouped together, rank highest of all farm operations in the amount of power utilized, with a total of approximately 22 per cent of the draft work or almost 16 per cent of the total power used; road hauling ranks

only slightly lower; threshing stands highest in the stationary operations, requiring over 25 per cent of all the stationary power utilized; and pumping for irrigation and drainage rank next, using over 20 per cent of this type of power."

ESTIMATED NUMBER OF POWER UNITS AVAILABLE ON FARMS IN THE
UNITED STATES, JANUARY 1, 1924

Oxen	200,000	Stationary engines	2,500,000
Horses	15,916,000	Electric installations	500,000
Mules	4,654,000	Windmills	1,000,000
Tractors	450,000	Automobile on farms.....	4,500,000
Trucks	356,000		

NOTE.—Figures as of December 31, 1928, from *The Farm Journal*: tractors, 781,281; trucks, 697,300; automobiles, 4,729,600.

GASOLINE HAS BUILT ROADS

State gasoline taxes (see "Taxation of the Petroleum Industry and Petroleum Products") collected during the last ten years have been a large factor in the progress that has been made in the improvement of the state and federal aid highway systems. These taxes now represent nearly one-third of the total of all funds available for road purposes.

Petroleum asphalt is used in the construction and maintenance of city pavements and rural highways throughout the country, and in recent years the use of asphaltic road oils and cut-back asphalts in the treatment and construction of low cost and secondary roads has increased very rapidly. (See "Utilization of Asphalt and Asphaltic Products.")

MOTOR TAXES AND THE NATIONAL ROAD BILL

Special levies on motor vehicles in 1928 totaled \$668,000,000, according to the National Automobile Chamber of Commerce, chiefly comprising registration fees and state gasoline taxes. Adding personal property tax of \$140,000,000, the grand total of motor taxes in 1928 was about \$808,000,000.

If taxes paid by the petroleum industry and the automobile manufactures were added to this total, it would

appear that the people who buy, operate, and manufacture motor cars and who produce, buy, and burn gasoline are paying the good roads bill which now runs, according to the U. S. Bureau of Public Roads, nearly a billion and a half dollars annually.

MOTOR TAXES IN 1928

SPECIAL MOTOR VEHICLE TAXES

Federal—Excise tax of 3 per cent on passenger cars and buses (repealed May 29, 1928).....	\$20,386,176
State—Registration fees	\$322,630,025
Gasoline tax (net).....	304,871,766
	627,501,791
Municipal	20,000,000
Total special taxes.....	\$667,887,967
Personal property tax.....	140,000,000
Grand total	\$807,887,967

Authority: National Automobile Chamber of Commerce.

THE PETROLEUM INDUSTRY AND AVIATION

In addition to furnishing fuel and lubrication for airplane engines, the petroleum industry figures in the airport end of aircraft development (see "Utilization of Gasoline"). The automobile demanded good roads. The airplane demands its airports. In the general flying which has begun it is needless to say that the towns without airports are the towns to which air traffic does not come, and they are not the towns at which travelers stop en route to somewhere else.

The inauguration of contract mail and other routes forced the establishment of new airports or improvement of existing airdromes at every station stop along airways, either directly by the city, in its behalf by civic organizations, or by private enterprise. Everywhere else civic interest has been stirred by the progress of air transport, and cities all over the country and off the airways are working with projects of varying degrees of excellence. These aviation facilities may be rated under the air commerce act. The value of land and improvement varies greatly, running as high as \$40,000 to more than \$1,000,000. Construction of airports is calling for the use of asphalt for paved runways,

roads, taxiways, landing strips, hangar aprons and floors, approaches, and parking spaces.

INDEX NUMBERS OF PRODUCTION FACTORS OF CERTAIN INDUSTRIES *

Automobile manufacturing and the associated industry of rubber tire building have had similar experiences since 1914 with respect to production factors. The striking changes which the automobile industry has experienced are increases in production, primary power available, and productivity per man-hour, with a decrease in unit prime cost.

Although the over-all percentage changes in production factors of the petroleum industry are smaller than those of the automobile and tire industries, they present the same characteristics. Production has consistently increased since 1914. Productivity per man-hour, which decreased slightly between 1914 and 1919, consistently increased thereafter. Primary power utilized increased at nearly a uniform rate up to 1923, and held that level—with only a slight increase—up to 1925. The man-hours worked increased from 1914 to 1919, and have fluctuated but little since. The year 1919 also shows a change in direction of the curve of unit prime cost, which dropped sharply down to 1923, and then continued at a nearly uniform level.

INDEX NUMBERS OF PRODUCTION FACTORS OF THE AUTOMOBILE INDUSTRY,
1914-1925

Year	Physical production	Man-hours	Productivity per man-hour	Wages paid	Cost of materials	Prime cost	Primary power	Primary power per man-hour	Unit prime cost
1914.....	100	100	100	100	100	100	100	100	100
1919.....	353	250	141	468	540	526	270	108	149
1920.....	384	289	133	...	...	...	...	...	...
1921.....	333	155	215	331	378	370	...	...	112
1922.....	554	210	264	...	...	...	...	...	...
1923.....	870	295	295	610	735	710	416	141	82
1924.....	804	278	289	...	...	...	...	...	...
1925.....	988	319	310	510	720	681	485	152	69

* "Technical Changes in Manufacturing Industries," from the Report of the President's Conference Committee on Recent Economic Changes in the United States. Data compiled from U. S. Census of Manufactures, 1925, and Monthly Labor Review.

PETROLEUM

INDEX NUMBERS OF PRODUCTION FACTORS OF THE RUBBER TIRE INDUSTRY,
1914-1925

Year	Physical production	Man-hours	Productivity per man-hour
1914.....	100	100	100
1919.....	394	303	130
1921.....	309	163	190
1923.....	527	198	266
1924.....	580	193	301
1925.....	680	219	311

INDEX NUMBERS OF PRODUCTION FACTORS OF THE PETROLEUM REFINING
INDUSTRY, 1914-1925

Year	Physical production	Man-hours	Productivity per man-hour	Wages paid	Cost of materials	Prime cost
1914.....	100	100	100	100	100	100
1917.....	...	...	...	...	...	...
1918.....	...	...	...	...	...	...
1919.....	197	214	92	462	384	388
1920.....	...	...	...	...	...	...
1921.....	235	217	108	530	425	430
1922.....	269	220	122	...	...	...
1923.....	302	237	129	535	440	445
1924.....	347	220	158	...	...	...
1925.....	399	225	177	540	580	580

Year	Primary power	Primary power per man-hour	Unit prime cost	Number of gallons of products per barrel of crude petroleum	Number of gallons gasoline per barrel of crude petroleum
1914.....	100	100	100	100	100
1917.....	...	...	...	93	129
1918.....	...	...	...	106	157
1919.....	187	88	197	104	157
1920.....	...	...	...	100	162
1921.....	...	...	183	101	166
1922.....	...	...	...	102	177
1923.....	305	129	148	101	188
1924.....	...	...	...	102	199
1925.....	307	137	145	103	210

While the total recovery of refined products per barrel of crude petroleum has changed but little, the amount of gasoline more than doubled between 1914 and 1925. This record is an indication of the improvement in technical processes.

INDEX NUMBERS OF PRODUCTIVITY PER MAN-HOUR FOR 12 PRODUCT GROUPS
(1914 = base year)

Year	Auto- mobiles	Rubber tires	Petroleum refining	Cement manu- facture	Blast furnaces	Steel works and rolling mills
1914.....	100	100	100	100	100	100
1917.....	...	...	...	...	...	...
1918.....	...	...	...	...	...	...
1919.....	141	130	92	102	95	101
1920.....	133	...	...	...	...	...
1921.....	215	190	108	121	110	93
1922.....	264	...	122	...	...	...
1923.....	295	266	129	130	154	138
1924.....	289	301	158	141	...	...
1925.....	310	311	177	158	*	†160

Year	Flour milling	Slaughter- ing and meat packing	Leather tanning	Cane sugar refining	Paper and wood pulp	Boots and shoes
1914.....	100	100	100	100	...	100
1917.....	...	...	...	...	94	...
1918.....	...	...	...	...	98	...
1919.....	95	92	110	78	‡100	115
1920.....	...	...	101	...	99	...
1921.....	120	119	133	82	90	123
1922.....	...	125	136	...	109	121
1923.....	126	128	140	101	110	121
1924.....	133	130	134	113	120	115
1925.....	139	127	128	127	126	117

* Figure included in 1925 figure for steel works and rolling mills.

† Includes figure for 1925 for blast furnaces.

‡ Base year for paper and wood pulp industries.

COMPARISONS OF OVER-ALL PERCENTAGE CHANGES IN THREE UNIT PRODUCTION
FACTORS FOR 12 PRODUCT GROUPS

(Computed by method of least squares)

Industry	Over-all percentage changes, 1919-1925		
	Productivity per man-hour (per cent increase)	Primary power per man-hour * (per cent increase)	Unit prime cost (per cent decrease)
Automobiles	139	41	56.5
Rubber tires	142	...	...
Petroleum refining	*93	57	29
Cement manufacture	52	39	29
Blast furnaces	†66	†32	18
Steel works and rolling mills..	†40	†20	20
Flour milling	42	20	38
Slaughtering and meat pack- ing	34	59	38
Leather tanning	24	33	47
Cane sugar refining.....	69	112	64
Paper and wood pulp.....	32	28	‡3.6
Boots and shoes.....	1	38	22

* Percentages calculated from terminal values.

† Percentage change from 1919 to 1923.

‡ Increase.

THE PETROLEUM INDUSTRY AS A PURCHASER AND A SHIPPER

As a purchaser of materials, the petroleum industry is an important factor in practically every industry of mining and manufacturing. The industry is one of the largest purchasers of steel and iron; one of the largest users of passenger and commercial motor vehicles; one of the largest purchasers of oil and gas engines, Diesel engines, pumps. It is a large purchaser of lumber, rope, paints, rubber; and of brass, tin, and chemicals. The petroleum industry in its purchases of tank vessels is second only to the mercantile marine in its orders to the shipyards. It is a large purchaser of tank cars.

GREATEST RAIL SHIPPER OF PRODUCTS

The railroads of the United States, according to the Interstate Commerce Commission, transport a larger tonnage of petroleum products than of any other manufactured com-

modity. Refined petroleum and its products, amounting to 56,776,625 tons, represented 18.33 per cent of all this class of freight carried by Class I roads in 1928. Ranking next to petroleum products in the I. C. C. list is bar and sheet iron, structural iron, and iron pipe, of which the petroleum industry is one of the largest purchasers. The total tonnage of manufactured commodities in 1928 was 309,801,880 tons.

In addition to shipping refined products, the petroleum industry is a large rail shipper of crude oil. In 1928 the railroads transported 7,632,000 tons of crude oil.

The principal manufactures in the order of their volume of tonnage (originating on line) are listed by the I. C. C. as follows:

RAIL MOVEMENT OF PRINCIPAL MANUFACTURED COMMODITIES,* 1928

	Tons	Per cent of total
Refined petroleum and its products.....	56,776,625	18.33
Bar and sheet iron, structural iron, and iron pipe.	41,925,024	13.53
Cement	26,029,164	8.40
Brick and artificial stone.....	18,930,109	6.11
Iron, pig and bloom.....	13,115,826	4.23
Fertilizers (all kinds).....	12,886,502	4.16

Authority: Interstate Commerce Commission.

* Class I Railroads.

SCIENTIFIC METHODS

Scientific methods in oil exploration, in drilling, and in oil recovery, as well as in the refining of oil, are attaining notable results. According to the Federal Oil Conservation Board, Report III, the discovery of new fields and of deeper sands in old fields has materially increased estimates of assured future supplies of oil.

“ The normal commercial initiative of private enterprise, to which the board appealed for action in reinforcement of supply, has fortunately not limited its activity to geologic and drilling exploration, but has made real progress in conservation engineering both in the field and in the refin-

ery," the board states. "Larger proportions of the oil are being recovered from the sands; the true function of gas in bringing the oil to the well and to the surface is being appreciated and utilized; and perhaps best of all is the definite trend toward cooperative methods in developing and operating new fields and in rejuvenating old fields."

Scientific methods in oil exploration include—in addition to surface and sub-surface geology, paleontology, and physics—the use of geophysical instruments such as the torsion balance, the seismograph, and magnetometer. (See "Supply of Petroleum and Production Methods," "Petroleum Facts and Figures," first edition, p. 74.) Oil field practice has undergone great changes in connection with coring, drilling methods, cementing, etc.

In oil recovery, the use of the air gas lift and the water flooding method have had revolutionary results. (See also "Production of Oil in the United States: Function of Natural Gas in the Production of Oil.")

No less striking has been the development of new processes in the refining of oil, notably the cracking process. (See "Refineries and Refining in the United States.")

TENDENCIES AMONG COMMODITY PRICES

The net movement of prices of all commodities, at wholesale, has been slightly downward during the period 1922-1927, according to the President's Conference Committee on Recent Economic Changes in the United States; but the differences between the movements of the major commodity groups have been even greater than those which developed during the pre-war era. As for the earlier period, farm products and foods have gained, relatively; while metals, fuels, and house furnishings have lost. Building materials, and chemicals and drugs have reversed their relative positions. Of the nine groups, six have declined (five substantially); two have risen appreciably, and one has remained practically at a level.

TENDENCIES AMONG COMMODITY PRICES, AT WHOLESALE
(Minor groups of the United States Bureau of Labor Statistics)

Commodity group	Average annual rate of change, 1922-1927 *
	<i>Per cent</i>
Rubber, crude	+ 16.8
Textile products (other than cotton, silk, and wool)	+ 6.0
Livestock and poultry	+ 5.5
Meats	+ 5.1
Drugs and pharmaceuticals †	+ 4.6
Grains	+ 3.5
Essential oils †	+ 2.7
Butter, cheese, and milk	+ 1.9
Nonferrous metals	+ 1.9
Crude drugs †	+ 1.2
Boots and shoes	+ 0.8
Chemicals	+ 0.6
Leather	+ 0.4
Foods (other than butter, cheese, milk, and meats)	+ 0.3
Cattle feed	+ 0.1
Furnishings	+ 0.1
Woolens and worsted goods	0.0
<i>All commodities</i>	- 0.1
Anthracite coal	- 0.2
Paper and pulp	- 0.5
Brick	- 1.1
Farm products (other than grains, livestock, and poultry)	- 1.2
Structural steel	- 1.4
Hides and skins	- 1.5
Portland cement	- 1.7
Petroleum products	- 1.8
Cotton goods	- 1.8
Lumber	- 1.9
Iron and steel	- 1.9
Furniture	- 3.7
Bituminous coal	- 4.5
Coke	- 5.6
Silk and rayon	- 5.8

* The index numbers from which these rates of change have been computed are the revised measures on the 1926 base.

† Index numbers of the *Oil, Paint and Drug Reporter*.

Taking the minor groups, it is noted that petroleum products show an average annual decline in wholesale prices for the period of 1.8 per cent, which compares with an average decline for all commodities of 0.1 per cent.

TENDENCIES AMONG COMMODITY PRICES, AT WHOLESALE
(Groups of the United States Bureau of Labor Statistics)

Commodity group	Average annual rate of change 1922-1927 *	Commodity group	Average annual rate of change 1922-1927 *
	<i>Per cent</i>		<i>Per cent</i>
Foods	+ 2.3	Building materials	- 1.3
Farm products	+ 1.2	Textile products	- 1.5
Hides and leather products	+ 0.2	Metals and metal products	- 1.5
<i>All commodities</i>	- 0.1	House furnishings	- 1.5
Chemicals and drugs.....	- 0.5	Fuel and lighting.....	- 2.7

* The index numbers from which these rates of change have been computed are the revised measures on the 1926 base.

The net movement of the prices of all commodities, at wholesale, has been slightly downward during this period, but the differences between the movements of the major commodity groups have been even greater than those which developed during the prewar era. As for the earlier period, farm products and foods have gained, relatively, while metals, fuels, and house furnishings have lost. Building materials and chemicals and drugs have reversed their relative positions.

GASOLINE PRICES LOW COMPARED WITH OTHER COMMODITIES

The average wholesale prices of gasoline in the United States in 1928 were only slightly higher than in 1913, the pre-war year, according to the index figures for average wholesale prices of all commodities published by the U. S. Department of Labor. With 1926 as a basis, the index number for gasoline in 1928 was 89.5, compared with 84.7 in 1913.

Gasoline sold considerably cheaper than the average of all commodities, which in 1928 was 97.7. In other words, the 1926 dollar would purchase \$1.105 of gasoline, as against \$1.023 of all other commodities.

Comparing gasoline prices with the prices of other commodities in general use shows that it sold on a comparative basis in 1928 cheaper than eggs, sugar, butter, milk, bread, and shoes.

INDEX NUMBERS OF WHOLESALE PRICES OF COMMODITIES, 1926 = 100
(Average for the Year)

Year	Farm products	Foods	Textile products	Fuel and lighting	Metal and metal products	Building materials	Chemicals and drugs	House furnishings	Miscellaneous	All commodities	Gasoline
1913.....	71.5	64.2	57.3	61.3	90.8	56.7	80.2	56.3	93.1	69.8	84.7
1914.....	71.2	64.7	54.6	56.6	80.2	52.7	81.4	56.8	89.9	68.1	72.5
1915.....	71.5	65.4	54.1	51.8	86.3	53.5	112.0	56.0	86.9	69.5	69.6
1916.....	84.4	75.7	70.4	74.3	116.5	67.6	160.7	61.4	100.6	85.5	115.7
1917.....	129.0	104.5	98.7	105.4	150.6	88.2	165.0	74.2	122.1	117.5	119.5
1918.....	148.0	119.1	137.2	109.2	136.5	98.6	182.3	93.3	134.4	131.3	121.8
1919.....	157.6	129.5	135.3	104.3	130.9	115.6	157.0	105.9	139.1	138.6	123.2
1920.....	150.7	137.4	164.8	163.7	149.4	150.1	164.7	141.8	167.5	154.4	147.5
1921.....	88.4	90.6	94.5	96.8	117.5	97.4	115.0	113.0	109.2	97.6	131.4
1922.....	93.8	87.6	100.2	107.3	102.9	97.3	100.3	103.5	92.8	96.7	126.4
1923.....	98.6	92.7	111.3	97.3	109.3	108.7	101.1	108.9	99.7	100.6	103.9
1924.....	100.0	91.0	106.7	92.0	106.3	102.3	98.9	104.9	93.6	98.1	90.6
1925.....	109.8	100.2	108.3	96.5	103.2	101.7	101.8	103.1	109.0	103.5	95.8
1926.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1927.....	99.4	96.5	95.7	86.5	98.2	93.3	96.6	98.2	89.9	95.4	94.3
1928.....	105.9	101.0	96.3	82.8	99.8	93.7	95.5	97.4	83.0	97.7	89.5

INDEX NUMBERS OF WHOLESALE PRICES OF SPECIFIED PRODUCTS, 1926 = 100

	Gasoline	Eggs	Sugar	Butter	Milk	Bread	Shoes
1913.....	84.7	70.0	77.9	72.7	56.9	60.6	48.6
1914.....	72.5	74.7	85.9	67.5	53.4	63.0	49.6
1915.....	69.6	72.3	101.5	67.4	53.9	67.9	50.8
1916.....	115.7	82.4	125.5	76.9	58.2	68.1	58.0
1917.....	119.5	112.9	140.7	96.3	81.4	99.0	74.2
1918.....	121.8	137.0	142.2	116.4	99.5	104.1	87.9
1919.....	123.2	148.7	163.1	136.6	108.4	106.3	118.8
1920.....	147.5	160.1	231.2	138.5	108.9	124.6	139.9
1921.....	131.4	113.7	112.4	97.8	96.0	110.9	109.4
1922.....	126.4	97.6	108.4	91.5	94.5	102.4	101.6
1923.....	103.9	97.5	154.0	105.6	98.7	98.4	100.4
1924.....	90.6	102.5	135.8	96.4	88.4	99.9	97.7
1925.....	95.8	112.0	99.8	102.3	99.2	100.0	99.9
1926.....	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1927.....	94.3	89.9	106.2	106.6	103.0	100.0	100.5
1928.....	89.5	92.6	101.3	106.9	105.6	100.0	105.5

TREND OF GASOLINE PRICES IN FIFTY UNITED STATES CITIES

A compilation of gasoline prices in fifty representative cities of this country on the first day of each month shows over the period 1918-1928, inclusive, the following (the prices are those of the major marketing companies) :

1. That the average price of gasoline charged to the motorist at service stations was 22.63 cents a gallon.
2. That state gasoline taxes added 1.23 cents a gallon to the average price paid by the motorist.
3. That the total average price, including the tax, paid by the motorist was 23.86 cents a gallon.

The table showing gasoline prices in the same cities as of May 1, 1929, reveals the following :

1. That the average price of gasoline charged to the motorist at service stations was 17.52 cents a gallon.
2. That the state gasoline taxes added 3.5 cents to the average price paid by the motorist.
3. That the total average price, including the tax, paid by the motorist was 21.02 cents per gallon.

AVERAGE GASOLINE PRICES
IN 50 REPRESENTATIVE CITIES IN UNITED STATES
(Service station prices, exclusive of tax)

	City	State	Average 11 Years 1921-1928	Average 8 Years 1921-1928
	<i>Average United States</i>		.2263	.2109
1	Portland	Maine	.2496	.2347
2	Manchester	New Hampshire	.2498	.2350
3	Burlington	Vermont	.2509	.2340
4	Boston	Massachusetts	.2460	.2291
5	Providence	Rhode Island	.2466	.2297
6	Hartford	Connecticut	.2505	.2364
7	Buffalo	New York	.2337	.2168
8	New York	New York	.2500	.2373
9	Newark	New Jersey	.2269	.2138
10	Philadelphia	Pennsylvania	.2405	.2223
11	Dover	Delaware	.2420	.2244
12	Baltimore	Maryland	.2259	.2128
13	Washington	Dist. of Columbia	.2282	.2160
14	Charleston	West Virginia	.2309	.2157
15	Norfolk	Virginia	.2252	.2099
16	Charlotte	North Carolina	.2349	.2163
17	Charleston	South Carolina	.2236	.2076
18	Atlanta	Georgia	.2327	.2163
19	Jacksonville	Florida	.2140	.1972
20	Birmingham	Alabama	.2270	.2091
21	Vicksburg	Mississippi	.2128	.1954
22	Memphis	Tennessee	.2012	.1860
23	Lexington	Kentucky	.2197	.2036
24	Youngstown	Ohio	.2258	.2072
25	South Bend	Indiana	.2097	.1972
26	Chicago	Illinois	.2060	.1927
27	Detroit	Michigan	.2142	.2012
28	Milwaukee	Wisconsin	.2086	.1957
29	Twin Cities	Minnesota	.2110	.1956
30	Fargo	North Dakota	.2364	.2212
31	Huron	South Dakota	.2204	.2051
32	Omaha	Nebraska	.2043	.1874
33	Des Moines	Iowa	.2061	.1936
34	St. Louis	Missouri	.2015	.1880
35	Wichita	Kansas	.1988	.1841
36	Tulsa	Oklahoma	.2020	.1829
37	Little Rock	Arkansas	.2128	.1899
38	New Orleans	Louisiana	.1997	.1818
39	Houston	Texas	.2082	.1873
40	Albuquerque	New Mexico	.2493	.2365
41	Denver	Colorado	.2175	.1951
42	Casper	Wyoming	.2072	.1957
43	Butte	Montana	.2478	.2284
44	Boise	Idaho	.2619	.2483
45	Salt Lake City	Utah	.2498	.2318
46	Reno	Nevada	.2503	.2322
47	Phoenix	Arizona	.2549	.2384
48	San Francisco	California	.2004	.1939
49	Portland	Oregon	.2073	.1990
50	Spokane	Washington	.2479	.2391

GASOLINE PRICES 1918-1930

U.S.

AVERAGE U.S.
FIFTY REPRESENTATIVE CITIES

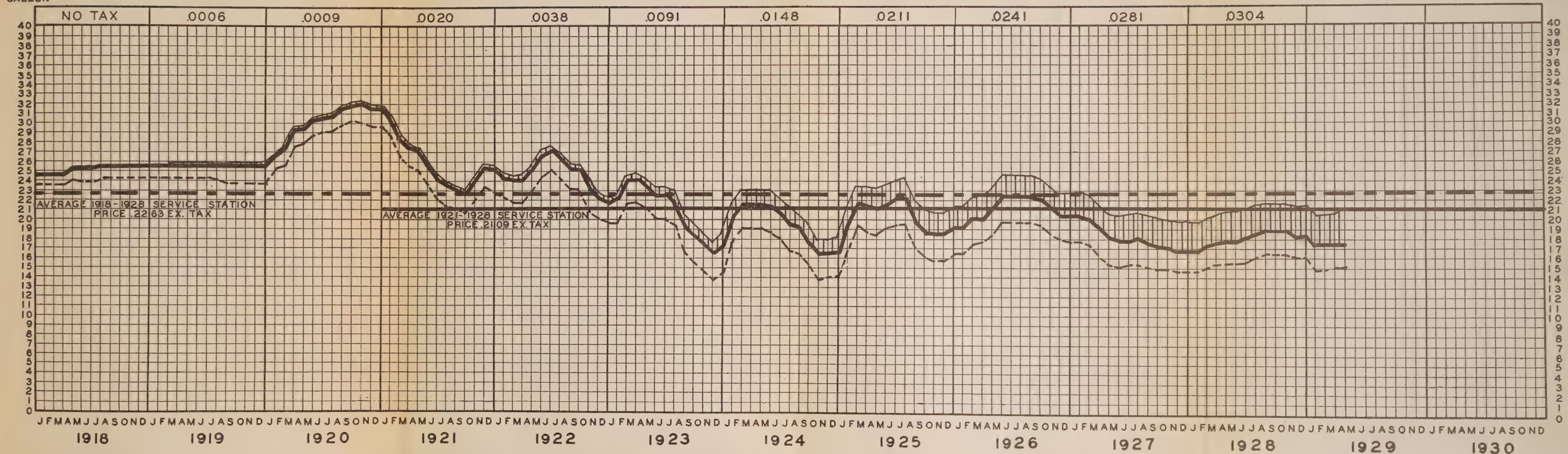
OF THE

MAJOR MARKETING COMPANIES

CENTS
PER
GALLON

- SERVICE STATION INCLUDING TAX.
- ▨ STATE GASOLINE SALES TAX.
- SERVICE STATION EXCLUDING TAX.
- TANK WAGON EXCLUDING TAX.

CENTS
PER
GALLON



The service station price of gasoline, as shown by the compilation, has been consistently under the 11-year average virtually since 1923, which year marked the beginning of the condition of overproduction in the oil industry.

The average service station price of gasoline for the period 1921-1928, inclusive, for these cities was 21.09 cents a gallon, and the average tax 1.67 cents, making the total price to the motorist for the period average 22.76 cents a gallon.

No state gasoline tax was in effect in 1918. The tax began early in 1919 with a rate of 1 cent a gallon levied by one state. The compilation covering the fifty representative cities shows the upward trend of state gasoline taxes, the average tax at the end of 1928 amounting to 3.04 cents a gallon. The average tax as of May 1, 1929, was 3.5 cents.

The gasoline tax being paid in the fifty cities represented less than 9 per cent of the service station price at the end of 1924 in these cities; while as of May 1, 1929, it represented approximately 20 per cent.

The compilation also shows that the margin between the tank wagon and service station prices, exclusive of taxes, is constantly widening.

It is well known that in many places there are discounts and allowances that make the return to the refiner or wholesaler today considerably less than this chart would indicate.

TAXATION OF THE OIL INDUSTRY AND PETROLEUM PRODUCTS

OIL INDUSTRY TAXES

The petroleum industry in 1928 paid considerably over one hundred million dollars in taxes. Returns received by the American Petroleum Institute, representing approximately 75 per cent of the producing and refining industry, showed an aggregate of \$102,224,827 of taxes. This does not include pipe line companies, which represent an investment of something like one billion dollars.

The taxes covered by reporting companies include federal income, state income and franchise taxes, *ad valorem* taxes, state oil and gas production taxes, oil inspection fees, licenses and permits, and miscellaneous taxes. Federal and state income taxes paid in 1928 were those based upon 1927 earnings; while other taxes paid were those levied during the calendar year 1928.

In addition to taxes paid directly by the industry, sales taxes are levied against certain petroleum products. Every state in the country, and also some municipalities, are now taxing gasoline. In some states there is also a sales tax on lubricating oil. State gasoline taxes paid by motorists in 1928 totaled \$305,000,000. Collection of these taxes is made by the petroleum marketing industry.

The following summarizes taxes paid directly in 1928 by the 75 per cent of the producing and refining industry reporting:

Federal and state income, and <i>ad valorem</i> taxes.....	\$82,308,285
Oil and gas production, oil inspection, licenses and permits, etc....	19,916,542
Total	<u>\$102,224,827</u>

The general classification of taxes given above scarcely reveals the variety of taxes levied against the oil industry

and petroleum products. The general property taxes begin with the crude oil in the ground. In the important oil producing states of Oklahoma and Texas a gross oil and gas production tax is levied upon the value of the product. Oklahoma has a production tax of 3 per cent of the gross value of oil and gas, less royalty interest. The total amount of this tax for the fiscal year ended June 30, 1928, was \$9,452,709 (authority: State Auditor). Texas taxes production at the rate of 2 per cent of the gross value of oil and gas; and the oil producing industry in that state paid during the fiscal year ended September 30, 1928, \$4,571,615 (authority: Comptroller of Public Accounts). In the gross production taxes of Texas and Oklahoma are included some taxes on other minerals, but these comprise a very small proportion of the whole.

Louisiana levies a severance tax on oil produced, which from January 1 to July 31, 1928 (under the old law), amounted to 3 per cent of the market value of the oil and gas, and from August 1 to December 31, 1928 (under the new law), amounted to from 4 cents to 11 cents per barrel of oil, depending upon the gravity; and on the gas $\frac{1}{5}$ cent per 1,000 cubic feet (authority: Supervisor of Public Accounts). These taxes in 1928 amounted to \$975,865.

Arkansas taxes 2.6 per cent of the gross market value of oil and gas production, and the total tax paid during the fiscal year ended June 30, 1928 amounted to \$743,173 (authority: Commissioner of Revenues).

Montana taxes 2 per cent of the gross value of the oil at the well, this tax amounting to \$127,365 for the fiscal year ended June 30, 1928 (authority: State Board of Equalization).

Wyoming and New Mexico have no flat per barrel rate of taxation on oil produced. In Wyoming the tax is on the gross value of the oil, at the same rate as that applying to all property in the county where produced. This tax is estimated in Wyoming in 1928 to have totaled \$425,000 (authority: State Board of Equalization). The New Mexico

tax, based on state and county assessments, is estimated to have been \$500,000 in 1928 (authority: State Tax Commission).

California has a tax of .66443 mills per barrel of oil produced and 17.39 cents per acre on the proved oil lands of the state. Both rates cover the annual assessment on account of the "petroleum and gas fund." These taxes for the fiscal year ended June 30, 1928 totaled \$175,600. The 1929 assessment has been fixed at \$185,000; the rates not yet (June 1, 1929) determined (authority: State Oil and Gas Supervisor).

Tabulation of the above figures shows the following in oil and gas production taxes in the principal producing states for a 12 months' period:

Arkansas	\$743,173
California	175,600
Kentucky	111,659 ¹
Louisiana	975,865
Montana	127,365
New Mexico	500,000 ²
Oklahoma	9,452,709
Texas	4,571,615
Wyoming	425,000 ²
Total	<u>\$17,082,986</u>

¹ Tax amounts to 1 per cent of market value for state; $\frac{1}{2}$ per cent for county. Figures given above are for state tax only.

² Approximate.

The above taxes, of course, are in addition to state income, franchise, occupation, and capital stock taxes; neither do they include the land taxes and other real estates taxes paid by the oil industry in connection with its holding in the various states.

As soon as oil comes out of the earth and goes into transportation, it is subject to another excise in the nature of pipe line and storage taxes.

The petroleum refining industry in turn pays *ad valorem* taxes to states, counties, and municipalities; and taxes on finished products of petroleum begin as soon as the movement from the refinery takes place, in rolling stock and

tank car taxes; in licenses for trucks, tanks, pumps, service and bulk stations; and in the levy of sales taxes on gasoline.

Oil inspection fees are levied in the following states:

Arkansas	Missouri
Florida	North Dakota
Kansas	Oklahoma
Louisiana	South Carolina
Michigan	South Dakota
Minnesota	

Companies reporting to the American Petroleum Institute paid nearly \$3,000,000 in oil inspection fees in 1928, this including fees levied by some municipalities. They also paid in licenses and permits approximately \$2,500,000.

STATE TAXATION OF GASOLINE

In the last ten years motorists have paid more than a billion dollars in state gasoline taxes—\$900,000,000 in the last four years.

According to the Bureau of Public Roads (U. S. Department of Agriculture), total gasoline taxes in 1928 (including other receipts under the various state gasoline tax laws) amounted to \$305,233,842.

During 1929 all states will be taxing gasoline—New York and Illinois being the last states to pass gasoline tax laws, their laws being effective May 1 and August 1, 1929, respectively.

This form of taxation began in 1919, when Oregon placed a tax on gasoline of one cent per gallon. In recent years, not only has this form of taxation spread throughout the country, but the rate of the tax has shown a progressive tendency to increase. Today (June 1, 1929) no state is levying as small a rate as one cent per gallon. Eight states and the District of Columbia impose a tax of 2 cents per gallon; nine states, 3 cents per gallon; one state, $3\frac{1}{2}$ cents per gallon; twenty states, 4 cents per gallon; eight states, 5 cents per gallon; one state, 6 cents per gallon; while Illinois will be imposing a tax of 3 cents per gallon beginning August 1,

GASOLINE TAXES, 1928

TOTAL TAX EARNED ON MOTOR VEHICLE FUEL, ETC., REFUNDS, DISPOSITION OF FUND, AND GALLONS TAXED (From Reports of State Authorities)

State	Gross tax assessed prior to deduction of refund	Exemption refund; (deducted from gross tax)	Total tax earning on fuel for motor vehicles ¹	Other receipts, under tax law (licenses)	Grand total earning (tax and other receipts)	Disposition of grand total earning				Tax Rate, 1928			Net gallons of gasoline taxed, and used by motor vehicles	State	
						Collection cost ²	Construction and maintenance on rural roads		State (S) and County (C) road bond payment	For miscellaneous purposes	Cents per gallon				Date of rate change
							State highway	Local roads			Jan. 1	Dec. 31			
Alabama.....	\$6,497,551	\$245,013	\$6,497,551	\$110,746	\$6,614,297	\$35,479	\$2,725,893	\$3,296,387	\$556,538	.....	4	4	...	Alabama	
Arizona.....	2,263,215	301,633	2,038,202	36	2,038,238	107,656	1,261,412	756,826	.....	.....	4	4	...	Arizona	
Arkansas.....	5,654,415	301,633	5,382,782	.....	5,382,782	107,656	1,184,212	807,417	73,283,497	.....	5	5	...	Arkansas	
California.....	32,276,918	2,710,149	29,566,769	.....	29,566,769	45,739	\$19,680,087	\$9,840,343	.....	.....	3	3	...	California	
Colorado.....	4,280,393	339,169	3,921,224	.....	\$3,921,224	46,497	2,702,191	1,158,082	10 \$14,454	.....	3	3	...	Colorado	
Connecticut.....	3,468,782	.....	3,468,782	42,923	3,511,705	.....	3,511,675	.....	.....	.....	2	2	...	Connecticut	
Delaware.....	834,784	34,435	800,349	.....	800,349	15,341	800,349	2,247,045	11 2,254,096	.....	5	5	...	Delaware	
Florida.....	11,235,225	.....	11,235,225	22,392	11,257,617	.....	6,741,135	2,247,045	.....	.....	5	5	...	Florida	
Georgia.....	8,245,486	122,043	8,245,486	.....	8,245,486	4,200	5,150,804	2,060,321	13 1,030,161	.....	4	4	...	Georgia	
Idaho.....	2,005,098	48,525	1,883,865	158	1,884,023	13,450	1,870,573	.....	14 836,826	.....	2	4	2/25	Idaho	
Illinois.....	886,826	476,413	886,826	.....	886,826	19,142	7,438,938	2,789,602	16 929,867	.....	3	3	...	Illinois	
Indiana.....	11,653,962	663,918	11,177,549	.....	11,177,549	23,297	3,446,331	5,086,000	.....	.....	3	3	...	Indiana	
Iowa.....	9,109,546	544,669	8,595,628	.....	8,595,628	23,297	3,446,331	5,086,000	.....	.....	3	3	...	Iowa	
Kansas.....	5,393,510	.....	5,394,841	.....	5,394,841	23,278	4,517,041	877,800	.....	.....	2	2	...	Kansas	
Kentucky.....	6,741,781	.....	6,743,224	1,443	6,743,224	23,278	6,719,946	.....	.....	.....	5	5	...	Kentucky	
Louisiana.....	3,580,931	.....	3,580,931	.....	3,580,931	.....	3,580,931	.....	.....	.....	2	2	...	Louisiana	
Maine.....	3,288,178	95,704	3,192,384	.....	3,192,384	17,565	3,174,819	.....	17 1,084,675	.....	4	4	...	Maine	
Maryland.....	5,607,566	181,693	5,425,873	.....	5,425,873	2,600	4,338,698	.....	17 1,084,675	.....	4	4	...	Maryland	
Massachusetts.....	20,200,021	1,865,181	18,334,840	.....	18,334,840	90,122	9,499,452	5,399,874 (S)	3,000,000	18 346,392	(No tax)	3	...	Massachusetts	
Michigan.....	6,211,788	443,688	5,768,100	21 131,842	5,768,100	5,600	5,768,100	2,894,805	21 215,257	.....	2	2	12/1	Michigan	
Minnesota.....	5,564,711	151,784	5,096,533	.....	5,096,533	57,446	2,890,891	2,894,805	.....	.....	4	5	...	Minnesota	
Mississippi.....	7,100,013	.....	6,948,229	.....	6,948,229	10,280	6,890,783	.....	.....	.....	2	2	...	Mississippi	
Missouri.....	2,144,794	461,390	1,683,404	.....	1,683,404	.....	1,673,124	.....	.....	.....	3	3	...	Missouri	
Montana.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	...	Montana	

Nebraska.....	3,968,921	27,757	3,941,164	6,761	3,934,403	265,593	.....	2	2	.....	197,058,187	Nebraska	
Nevada.....	575,069	43,883	531,186	.....	285,593	.....	.....	4	4	.....	13,279,660	Nevada	
New Hampshire.....	1,928,602	44,427	1,884,175	840	1,412,501	.....	22 470,834	4	4	1/1	47,079,932	New Hampshire	
New Jersey.....	8,446,980	.....	8,446,980	23,406	8,368,341	11,995	.....	2	2	.....	422,346,478	New Jersey	
New Mexico.....	1,836,900	.....	1,836,900	15,137	1,852,037	37,041	(S) 400,500	5	5	.....	36,738,005	New Mexico	
New York.....	10,117,614	330,603	9,787,011	9,887	9,787,011	9,887	25 (S) 2,908,042	(No tax)	4	4	24	244,675,269	New York
North Carolina.....	2,202,679	724,572	1,478,107	1,362	1,479,469	25,000	.....	2	2	.....	73,973,434	North Carolina	
North Dakota.....	.....	.....	.....	.....	.....	.....	.....	4	4	.....	.....	North Dakota	
Ohio.....	25,818,985	993,286	24,885,699	.....	24,885,699	.....	16 4,977,140	3	3	.....	829,523,293	Ohio	
Oklahoma.....	8,170,719	22,818	8,147,901	.....	8,147,901	.....	4,147,616	3	3	.....	279,996,597	Oklahoma	
Oregon.....	4,308,417	300,158	4,008,259	8,793	3,989,466	.....	2,715,967	3	3	.....	144,284,704	Oregon	
Pennsylvania.....	21,998,064	.....	21,998,064	.....	21,998,064	.....	4,707,738 (S)	3	3	.....	733,268,795	Pennsylvania	
Rhode Island.....	1,182,328	.....	1,182,328	.....	1,182,328	.....	.....	2	2	.....	59,116,396	Rhode Island	
South Carolina.....	5,539,243	21,003	5,518,240	.....	5,518,240	.....	(S) 295,582	5	5	.....	110,364,802	South Carolina	
South Dakota.....	849,158	81,005	3,158,873	7,688	3,158,873	.....	(C) 551,824	4	4	.....	78,995,809	South Dakota	
Tennessee.....	5,134,600	.....	5,134,600	51,346	5,083,254	.....	(S) 940,970	4	4	.....	171,153,333	Tennessee	
Texas.....	17,945,037	.....	17,945,037	.....	13,458,778	.....	28 4,486,259	3	29 2	9/1	681,135,373	Texas	
Utah.....	1,664,247	.....	1,664,247	405	1,143,232	5,500	(S) 515,930	3 1/2	3 1/2	.....	37,377,166	Utah	
Vermont.....	1,118,882	.....	1,118,882	.....	1,118,882	.....	.....	3	3	.....	37,311,088	Vermont	
Virginia.....	8,616,239	.....	8,616,239	.....	5,744,159	.....	2,872,080	4 1/2	5	3/19	174,800,793	Virginia	
Washington.....	335,495	.....	4,206,515	.....	4,206,515	.....	(S) 32,000,000	2	2	.....	210,325,734	Washington	
West Virginia.....	154,391	.....	4,301,883	6,226	2,308,109	.....	.....	4	4	.....	107,947,068	West Virginia	
Wisconsin.....	7,142,928	286,169	6,856,759	9,985	2,521,106	.....	16 493,645	2	2	.....	342,837,969	Wisconsin	
Wyoming.....	955,851	1,534	954,317	2,373	951,944	.....	.....	3	3	.....	31,810,563	Wyoming	
Dist. of Columbia	1,271,586	8,438	1,263,148	.....	1,263,148	.....	33 1,263,148	2	2	.....	63,157,357	Dist. of Columbia	
Total.....	.....	.....	304,871,766	362,076	305,233,842	694,601	57,380,901	17,619,995	18,491,754	Aver. rate 3.00	54 10,178,344,771	Total	

NOTES:

¹ This is the net tax after deduction of refunds for exemptions according to law and represents the actual taxes available for disposal; the first two columns show only the procedure and are not totaled, being of minor importance.

² Collection costs in many states are paid from other state funds, and when amounts and sources are reported notes are entered below.

³ Back tax receipts.

⁴ On State Highway bonds, series G only.

⁵ Excludes 5,837,287 gallons consumed in a previous year taxed at 2 cents but not then reported.

⁶ Paid \$15,133 for collection from State Highway fund.

⁷ Includes \$484,450 on State Highway bonds and \$2,799,047 on local road bonds.

⁸ Includes amounts reported unapportioned.

⁹ Includes all expense of state inspector of oils.

¹⁰ Balance of oil inspection fees transferred to state general fund.

¹¹ For schools and school buildings \$2,247,045, and for state treasury \$7,051.

¹² For public schools.

¹³ Only January tax receipts reported as law was found invalid by supreme court, Feb. 24, 1923.

¹⁴ Held at disposal of court.

¹⁵ Only January consumption shown, remaining 11 months estimated at 671,000,000 gallons.

¹⁶ For city streets.

¹⁷ For Baltimore city streets and grade crossing elimination in city.

¹⁸ Gasoline tax of 2 cents effective January 1, 1929.

¹⁹ Estimated consumption 340,000,000 gallons.

²⁰ Appropriation of \$5,700 made by state.

²¹ State additional taxes in 3 counties assigned to sea-wall for road protection.

²² For flood damage.

²³ For state department of commerce and navigation.

²⁴ Estimated consumption 1,000,000 gallons.

²⁵ Allocation of fund estimated.

²⁶ State department of education of \$12,000.

²⁷ Indirect distillate tax of 2 1/2 cents, on 4,024,847 gallons consumed.

²⁸ Free school fund.

²⁹ Reduced according to Sec. 2 of 1927 law.

³⁰ State appropriation of \$11,700.

³¹ Transferred \$5,000 from motor vehicle fund.

³² Appropriation.

³³ For improvement and repair of Washington streets.

³⁴ For approximate total of all states add estimated amounts noted for Illinois, Massachusetts and New York.

Authority: Bureau of Agriculture

1929. The tax rate may be increased in some states during the year, inasmuch as there are still pending in current legislative sessions measures proposing to increase the tax rate on gasoline.

STATE GASOLINE TAXES

1921.....	\$4,700,000
1922.....	12,100,000
1923.....	36,800,000
1924.....	79,700,000
1925.....	146,100,000
1926.....	187,600,000
1927.....	251,800,000
1928.....	305,234,000

It is estimated that the gasoline tax now paid by the motorist averages around 25 per cent of the filling station price of gasoline.

DISTRIBUTION OF THE TAX

Gasoline tax measures are passed by legislatures as good road measures, *i. e.*, the revenues to be used for the construction and maintenance of roads. In a good many states, certain of these funds are used for other purposes. In 1928 Florida applied \$2,247,045 of its gasoline tax revenue to schools and school buildings; Georgia, \$1,030,161 to public schools; Texas, \$4,486,259 to the "free school fund"; while in new gasoline tax legislation there is a tendency in a number of states to divert funds for uses other than construction and maintenance of roads.

COLLECTION OF THE TAX

State gasoline taxes are paid by the motorist, *i. e.*, the tax is added to the retail price of the product. Under the various state gasoline tax laws, the collection of the tax is made by oil distributing companies, which practically have to guarantee the payment of the tax. In certain states an allowance is being made to cover the cost of collection by these companies, but generally the industry has collected the tax without compensation. In other words, the petroleum refining or marketing company selling gasoline to a dealer pays the tax to the state government on such a sale; the dealer in turn collects the tax from the motorist.

RELATION OF SPECIAL MOTOR TAXES TO HIGHWAYS

While the total rural highway income increased from \$1,149,430,896 in 1921 to \$1,465,076,204 in 1927, it will be noted that the proportion of this income borne by special motor vehicle taxes more than trebled in 1927; whereas the proportion from bonds was cut in half, and that received from general taxes declined slightly. In 1921, special motor vehicle taxes (fees, licenses, etc., and state gasoline taxes) amounted to 10.6 per cent of the total; in 1927, 35.2 per cent. Figures for 1927 are given because that is the last year for which all highway expenditure data are available.

SOURCES OF RURAL HIGHWAY INCOME—1921

Source	State		Local		Total	
Bonds.....	\$117,354,711	28.7%	\$320,754,562	43.3%	\$438,109,273	38.1%
General taxes..	106,327,366	26.0%	403,034,865	54.4%	509,362,231	44.4%
*Special taxes on motor vehicles.....	105,915,662	26.0%	16,710,504	2.3%	122,636,166	10.6%
Federal aid....	79,333,226	19.3%	.....	.....	79,333,226	6.9%
Total.....	\$408,930,965	100%	\$740,499,931	100%	\$1,149,430,896	100%
Per cent....	35.6%		64.4%		100%	

* Gasoline taxes were not imposed generally until later than 1921.

SOURCES OF RURAL HIGHWAY INCOME—1927

Source	State		County and Local		Total	
Bonds.....	\$90,979,230	13.7%	\$181,281,490	22.6%	\$272,260,720	18.6%
State or local taxes.....	18,769,561	9.4%	404,692,535	66.5%	423,462,096	40.7%
State or local appropriation	30,794,645		72,866,089		103,660,734	
Miscellaneous..	12,469,703		56,570,489		69,040,192	
Special taxes on motor vehicles (in- cluding gas taxes).....	429,673,259	64.8%	86,519,532	10.9%	516,192,791	35.2%
Federal aid....	80,459,671	12.1%	.....	.....	80,459,671	5.5%
Total.....	\$663,146,069	100%	\$801,930,135	100%	\$1,465,076,204	100%
Per cent....	45.3%		54.7%		100%	

RURAL HIGHWAY EXPENDITURES—1927

Function	State		Local		Total	
Construction...	\$400,038,378	60.1%	\$289,474,445	38.7%	\$689,512,823	48.8%
Maintenance...	138,783,358	20.9%	237,835,289	31.8%	306,618,647	26.7%
Miscellaneous...	47,881,923	7.2%	40,927,403	5.5%	88,809,326	6.3%
Equipment and machinery...	13,390,076	2.0%	.....		13,390,076	.9%
Principal on bonds.....	31,528,424	9.8%	104,562,005	24.0%	136,090,429	17.3%
Interest on bonds.....	33,545,347		74,744,775		108,290,122	
Total.....	\$665,167,506	100%	\$747,543,917	100%	\$1,412,711,423	100%
Per cent....	47%		53%		100%	

Authority: "Highway Tax Costs" by John E. Walker

PRODUCTION OF OIL IN THE UNITED STATES

FUNCTION OF NATURAL GAS IN THE PRODUCTION OF OIL

In its effort to increase efficiency of oil production, the American Petroleum Institute in 1927 undertook to collect data relative to the function of gas in the production of oil. A committee, known as the Gas Conservation Committee, was appointed, with the following personnel: E. W. Marland, Chairman; Henry McGraw, W. S. Farish, Thomas A. O'Donnell, Sid H. Keoughan, J. Edgar Pew, and L. P. St. Clair. Regional committees were formed, and approximately 250 oil company executives and operators, officials of the Institute, attorneys, petroleum engineers, government officials, and scientists considered and discussed reports made by these committees after exhaustive study.

The report of the Gas Conservation Committee was accepted by the directors of the Institute on December 8, 1927, thereby placing the Institute on record as favoring the control and efficient utilization of natural gas occurring with oil. In 1928, the data collected by the four regional committees were turned over to the newly created Division of Development and Production Engineering of the Institute, and a cooperative agreement between the Bureau of Mines and the Institute was made whereby the former has prepared the data for publication as a cooperative report by the Bureau and the Institute.

The preparation of the report was made by H. C. Miller, Senior Petroleum Engineer, U. S. Bureau of Mines, the report covering 256 printed pages, and has been published by the Institute under the title: "Function of Natural Gas in the Production of Oil." A complete summary of the report follows:

DEFINITIONS

Special terms are necessarily used in discussing problems of petroleum production engineering. Many of these

terms are relatively new and not in common usage throughout the United States. The following definitions of terms used are given to insure against possible misunderstanding in the discussion which follows:

1. Gas-oil ratio.—The number of cubic feet of gas produced per barrel of oil by a well.
2. Reservoir gas-oil ratio.—The number of cubic feet of gas per barrel of oil originally in the reservoir.
3. Recovery gas-oil ratio.—The number of cubic feet of gas produced from the reservoir per barrel of oil.
4. Circulated gas-oil ratio.—The number of cubic feet of gas introduced into the well for gas lift operations, per barrel of oil lifted.
5. Effective back pressure.—The pressure at a given point on the face of the oil-bearing formation in a well. Due to the great thickness of some oil zones, particularly in California, the effective back pressure in the lower part of the oil zone may be as much as several hundred pounds per square inch more than the effective back pressure in the upper part. For that reason the term "mean effective back pressure" is used to indicate the average effective back pressure on the series of oil sands comprising the productive zone.
6. Injected gas.—The gas put into an oil-producing sand for the purpose of maintaining or restoring rock (formation) pressure or for storage.
7. Pressure control.—The adjustment of pressures within a well to obtain the most efficient and economical utilization of the energy in the natural gas under pressure in the oil sands.
8. Flow bean.—A nipple or restriction that is placed in the flow line from wells to restrict and control the rate of flow of gas and oil from the wells. Sometimes called choker or flow nipple.
9. Deferred production.—Oil production held back in the producing formation as the result of the application of pressure control.

10. Controlled production.—Production of oil under the application of pressure control.
11. Stopcocking.—A production method for controlling gas pressures in oil wells by keeping the well closed in and the gas confined except during stated intervals when the oil is flowed or pumped.
12. Jamin effect.—The resistance offered to flow by alternating globules of liquid and bubbles of gas in channels of capillary dimensions.

I. THE IMPORTANCE OF NATURAL GAS IN THE PRODUCTION OF PETROLEUM

The conservation of natural gas in the production of oil is of paramount importance. For example, it is estimated that in 1927 in one field alone—the Burbank in Oklahoma—gas conservation would have resulted in the production of at least 20,000,000 additional barrels of oil. Had pressure control been applied to this field as a unit, approximately \$36,000,000 of additional revenue would have been realized in one year from oil that will remain unproduced because of uncontrolled production methods. Also, many wells would have flowed naturally for a longer time under pressure control, and lifting costs would have been reduced materially. The cost of lifting oil by natural flow is much less than by other means, and therefore a greater profit per barrel of oil would have been realized. Although the gas in excess of the estimated amount required to produce efficiently Burbank field's 1927 production had a potential value of approximately \$2,000,0000 at the casing head, it would have had a greater value as expulsive energy if utilized to its fullest extent in moving oil through the reservoir sands to the wells.

Pressure control of wells is a major factor in the production of oil. A better realization of what can be accomplished to conserve gas and increase the recovery of oil from the sands has come to the petroleum industry within recent years. Savings of oil and gas and increased earnings which

already have been effected in fields where pressure control has been applied are indicative of the results which may be accomplished by the petroleum industry if every operator will study his problems in the light of pressure control.

Function of Gas in the Reservoir

(a) Gas associated with or in contact with the oil in reservoir rocks provides the propulsive energy which moves oil to the wells. All petroleum engineers are agreed that where gas provides this energy the exhaustion of oil from oil-bearing formations is due more to depletion of the gas than to actual exhaustion of oil. Water and gravity also play a part in oil recovery, but gas usually provides the main force which moves oil through the reservoir rocks to the wells. Because of the influence of gas in the production of oil, and by reason of its importance, the common supply should be controlled in the common interest.

(b) The amount of gas associated with a barrel of oil depends largely upon pressure. Gas is commonly believed to exist in four phases in the reservoir:

1. As free gas in higher portions of the structure.
2. As a liquid where pressure is sufficiently high.
3. In solution in the heavier liquid hydrocarbons present.
4. Adsorbed at the interfacial surfaces.

(c) Natural gas in solution lowers the viscosity and surface tension of the oil in the reservoir, thereby reducing the resistance to movement of oil in the sand toward the well. The volume of gas held in solution in oil is in direct proportion to the pressure, if other conditions remain constant. Holding as much of the gas in solution in the oil as possible will, therefore, keep the oil more fluid, and through lowered surface tension and the lessened growth of bubbles will thereby reduce that resistance to flow which is known as the Jamin effect.

(d) Temperature measurements, where available, indicate that the production of oil and gas sometimes reduces the original formation temperature. Such temperature

changes as do occur probably are localized to the immediate vicinity of the well, possibly almost wholly within the well.

(e) Gas injection compensates to a degree for some of the harmful effects of producing oil with high gas-oil ratios, but it cannot reproduce original conditions in the reservoir. The factors considered of greatest importance are:

1. Time.
2. Lack of agitation.
3. Slow rate of diffusion.
4. Inability to replace adsorbed gas.
5. Change in character of gas returned due to extraction of gasoline.
6. Relative small number of injection wells as compared to producing wells.
7. Water encroachment.
8. Differential permeability (the inability to direct the gas to the particular sand desired).

(f) Repressuring with gases other than the original gas. The use of air is considered undesirable where the oil is asphaltic, or contains many unsaturated compounds which are readily oxidizable. Air is less soluble and does not reduce the viscosity or surface tension as does natural gas. Corrosion of casing and tubing, particularly if the oil be high in sulphur, is almost sure to result from the use of air as a substitute for gas. Also compressed air vitiates the gas still remaining in the reservoir rocks, and as the supply of gas for fuel is usually low in districts where air is used for repressuring, the returned air-gas mixture is often explosive and unfit for fuel purposes.

Flue gas can be denuded of its moisture content and used for drive purposes; this relieves most of the oxidation and explosive difficulties attending the use of air. Flue gas dissolves in oil and parallels the effect of air, in that about an equal amount is soluble in oil at the same pressure. There is an attendant increase in the viscosity of the crude about equivalent to that caused by air in the same proportion. The greatest difficulty with flue gas, however, is its corrosive character which is injurious to pipes, compressors, coolers,

and other metal equipment. Also, in some fields, sufficient quantities of flue gas are not available for extensive repressuring.

(g) There appears to be a lack of uniformity of opinion as to the character of flow in the sands. Data and opinions indicate that there may be viscous flow, turbulent flow, or a progressive mixture of the two, depending to some extent upon time and relative position in the reservoir. Other factors which are considered important in their influence upon the type of flow are the character of the oil, the amount of gas present, the pressure, and the size of the pore spaces through which the oil moves.

II. DEVELOPMENT METHODS

Well Spacing and Rate of Development

(a) The evils of too close spacing are principally economic. There are, however, losses of gas energy from by-passing of gas where wells are too closely spaced. Wells drilled too closely cause lessening of efficiency of expulsion of oil from reservoir sands by excessive friction. High Jamin effect results also in an early stage due to rapid drop in formation pressure, and consequently the formation of gas bubbles of increasing number and size in the vicinity of the well increases the resistance to movement of oil through the sands.

Wide spacing (within the drainage radius of wells) makes for slower drainage of sands; if operating methods are efficient, there is less loss of energy consumption per barrel of oil produced and therefore a greater ultimate recovery by ordinary methods.

No set rules as to the proper spacing of oil wells can be offered for consideration at this time. Calculations of well spacing must take into account physical factors such as formation pressure, relative quantity of gas, permeability of sands, gravity of oil, position on the structure, and the relation to the edge-water line. Since these factors are not the same on any two properties, the problem of spacing

wells to give the maximum efficiency of utilization of formation gas is not a matter that can be formulated and used with equal success indiscriminately.

(b) In the practical aspect, the rate of development is dependent upon economic factors, chief of which is the demand for oil. Simultaneous development of the entire structure to give all wells an equal start is recognized as most desirable, theoretically. As a substitute for this impossible condition, immediate initiation of gas injection is recommended, maintaining as nearly as possible the original reservoir pressure throughout the development period.

Data on the comparative recovery from tracts equally well located on the same structure in the Burbank field in Oklahoma, and leased by the Osage Indian Agency at different times, show that the first tracts drilled got larger wells, better sustained production, and higher ultimate recovery than those leased and drilled one or two years later.

(c) With regard to the location of wells on structure and the efficient utilization of formation gas, it is observed that if a property under consideration occupies an entire structure, and if the wells planned have considerable differences in structural elevation, it might be advisable to drill the edges of the structure first and defer the drilling of the higher portions where the relative quantity of gas is greater until the edge wells have had for some time the advantage of the full pressure of the formation gas. If this theory is correct, and it should be understood that it is purely theoretical, it might be advisable to space wells more widely on top of the structure than on the flanks.

(d) Drilling methods should be such as to avoid unnecessary losses of gas. Casing programs should be made properly to protect all gas and oil sands, even if economically unexploitable at the time. "Blowing in" wells should be prohibited. Two wells in the Cook pool, Texas, for example, were allowed to blow wide open for days in an attempt to blow them into oil, wasting 250,000,000 cubic feet of gas and getting one 10-barrel and one 26-barrel pumping well.

Efforts to convert dry gas areas into oil producing areas have caused waste of gas running into even larger figures in other areas.

II. OPERATING METHODS TO BEST UTILIZE RESERVOIR GAS ENERGY

(a) *Pressure Control*

Once a well is completed the first factor in point of time and importance is that of control or maintenance of back pressure on the face of the producing sand. Proper pressure control is highly desirable on wells. Where there is no pressure control, the gas-oil ratio is much greater than where pressure control is employed. To be most effective, however, pressure control should be cooperative throughout the pool. The amount of back pressure and the means employed depend largely on the individual well.

By maintaining pressure on the face of the producing sand the several effects of rapid decline of pressure are avoided by: (1) viscosity of oil being kept at a lower point; (2) the growth of gas bubbles is less, which is influential in preventing the increase of surface tension.

In many wells pressure control decreases the rate of production by lowering the pressure drop through which the expanding gas acts. This serves in the more efficient use of gas energy by lowering resistance to flow and also restrains the rapid encroachment of water, thereby preventing side-tracking of oil.

The amount of back pressure to maintain on a sand is determined by weighing the physical factors against the economic factors. If the pressure on the face of the sand is too great, possibly the gas-oil ratio may be increased due to low velocity of the fluid in the sand and increase in slippage and by-passing of gas. Also, in such cases the rate of recovery is low, particularly if the well is closely offset. As a rule, production men do not carry nearly enough back pressure on their wells to utilize the energy of the formation gas efficiently. From the physical standpoint, the most efficient back pressure will depend chiefly on the reservoir

pressure, the character of the sands, the character of the oil, well spacing, and to a certain extent the relative structural position of the well.

Inefficient utilization of gas from any individual well in a lease or reservoir will affect the ultimate recovery of that lease or reservoir as a whole. Gas conservation is, therefore, a cooperative problem. It is recommended that wells having a higher gas-oil ratio than the average for the reservoir should be shut in to the point where the gas-oil ratio is equal to that of the average, or should be completely shut down until such time as the gas-oil ratio in the reservoir shall have changed to a point comparable to the gas-oil ratio of the higher ratio well.

The amount of back pressure to be held against producing sands decreases with the age of wells, because greater resistance to flow underground requires more energy, and this energy must be applied by increasing the quantity or the expansion ratios of the gas. With decreased pressure on the sand, viscosity and friction is increased, and consequently more energy and an increased expansion ratio or greater gas-oil ratio is required.

The principal objection to back pressure control on the part of certain executives is deferment and possible loss of production. Deferred production, however, is generally recovered in a short time; generally when it is recovered, the wells produced under pressure control still have much larger daily productions, and therefore greater futures, than the wells which were allowed to flow wide open.

Data on the effect of future production of shutting in wells show the following:

- (a) Considering fields as a whole, ultimate production is probably not decreased. Deferred production is obtained usually within two or three years.
- (b) In certain fields in the San Joaquin Valley in California, it was found that some of the properties on top of structures suffered from drainage due to gravity. The gas pressure in those fields was very low, and consequently the oil drained down the flanks of the structure by gravity.

- (c) Evidence from experience in the Torrance field, California indicates that in small areas, deferred production may never be recovered, especially in fields where the gas is the prime production factor and when adjacent properties continue to produce.
- (d) All the evidence indicates that any shut down must be cooperative throughout the structure in order to be successful.

The principal means available for pressure control in a well are:

1. Restriction of flow by flow beans or orifices at the casing head or at the bottom of the tubing.
2. Size and depth of tubing.
3. Stopcocking, or part time operation.
4. Variation of pressure and quantity of circulated gas in case of gas-lift wells.

Pressure control is possible for pumping wells through:

1. Regulation of fluid level by:
 - (a) Location of pump.
 - (b) Intermittent pumping.
 - (c) Varying length and speed of strokes.
2. Regulation of gas pressure by:
 - (a) Shutting in gas either at all times or when well is not being pumped (in effect, stopcocking).

Other beneficial effects of pressure control in addition to better utilization of reservoir gas energy are:

1. Retardation of water encroachment.
2. Longer flowing life and probability of lower operating costs.
3. Minimum sand trouble where wells are apt to make much sand.

(b) *Gas and Air Lift Methods*

The gas, or air lift, is a mechanical method of supplementing the reservoir energy by assisting in lifting the oil from the bottom of the well to the surface. The formation is thus relieved of a certain expenditure of gas energy which possibly might be put to better use in bringing more oil into the well. Field data indicate that the gas lift should be

installed in a well immediately prior to the period when the well "heads." Some data show that it is inadvisable, at least in the town-lot area in California, to install the gas lift in wells whose production can be handled with a standard oil well pump. In other words, wells whose production is less than about 200 barrels a day will have a more efficient gas-oil ratio and lower lifting costs usually when pumped "on the beam."

Efficient operation of a well, whether the well is flowing naturally on the gas lift, or pumped on the beam, requires that the amount of gas produced with the oil be known. This knowledge is a fundamental necessity in oil production. Without this knowledge, conclusions as to the effect and use of gas must be drawn blindly.

(c) *Gas Injection*

The importance of gas injection, in one or more of its various phases, is recognized as perhaps the outstanding feature of the moment in oil production. Gas injection should, wherever possible, begin in the early stages of development—that is, should be of the pressure-maintenance type. Data presented tend to minimize the difficulties of high pressure injection. Attention is called to the fact that only a relatively small amount of additional work is necessary to carry on the compression from 600 pounds pressure up to pressures of 1250 or 1500 pounds per square inch.

In this connection, the use of double gas separators or gas traps is recommended to save compression costs. The high pressure trap might be kept at 250 to 300 pounds pressure, thus saving a large part of the work of recompression; the gas remaining in the oil discharged from the first trap is then released from the oil in a low pressure separator.

Early installation of pressure maintenance is put forward as a means of avoiding the necessity of immediate development, beyond the needs of the country for oil. If the reservoir pressure be maintained, an orderly development program could be followed and the later wells would have

initial production approximately that of the first wells drilled.

Of the gases available for repressuring, natural gas of the original composition is most desirable if true repressuring is desired, the gas being returned without the extraction of the gasoline fractions. Flue gas and air follow in preference in the order named. Where the only object is gas drive, the extraction of the gasoline is considered unimportant by some engineers, while others hold that the heavier hydrocarbons are needed to help "wash off" the oil adhering to the sands.

The injection of gas into depleted or partly depleted oil reservoirs is a means of storing surplus gas at times when markets for gas are not available. Although it is not known what proportion of the injected gas can be recovered later when a market for gas exists, operators in California are of the opinion that the cost of injecting and storing this gas will be returned at a profit sufficiently large to warrant current expenditures for such storage. The fact that nearly 50,000,000 cubic feet of gas was stored daily in certain California fields in the summer of 1928 shows that operators are sincere in their belief that gas injection is a conservation measure which offers several opportunities for success and profit.

The operation of producing wells by gas injection differs in no important way from best practice in the case of natural flow unassisted by injected gas.

(d) *The Gas-Oil Ratio as an Operating Guide*

The importance of a proper conception of the value of the gas-oil ratio as a measuring stick of production efficiency is stressed, and in this connection attention is called to the often neglected pressure factor. Pressure is as fundamental as volume. Obviously, the force exerted by 1000 cubic feet of gas under, say 100 pounds pressure, is far less than the force exerted by the same quantity of gas under a pressure of 1000 pounds per square inch. The fundamental

factor is the combination of pressure and volume, which together make the force exerted by the gas. It is the force that is important. In comparing production methods at the same well, the volume alone can be used as the index, for the underground pressure will be the same; but when comparing production efficiencies in two or more wells, or in wells at different fields where conditions cannot be exactly alike in all details, the index should include both pressure and volume.

III. ADVANTAGES OF AN IDEAL COOPERATIVE DEVELOPMENT PLAN

Among the more important advantages of an ideal cooperative development plan, with particular reference to proper utilization of reservoir gas energy, are the following: (1) A carefully planned development program is made possible, by which unnecessary offsets, too close spacing, and other evils of competitive drilling may be avoided; (2) overproduction in any one area is prevented, making proration or shutting in of production easily accomplished; (3) the shutting in of wells which have excessively high gas-oil ratios is made possible, the application of gas injection processes can be made at the best points without regard to lease boundaries, and uniform pressure control can be exerted without danger of loss of production; (4) exchange of information is facilitated, and the most efficient engineering control is made possible at moderate cost. Aside from the advantages directly concerned with the conservation of reservoir gas energy it will (5) make possible the reduction of overhead and operating costs through the reduction of personnel and elimination of duplication of equipment, and (6) facilitate repair work on wells and means to combat water encroachment.

U. S. CRUDE OIL PRODUCTION AND VALUE OF OIL

During the last decade, the petroleum industry has been under the necessity of constantly finding new oil sources, if the demands of the motorist and other users were to be supplied. How well it has succeeded is shown by the fact that in 1918 the total oil production of this country was 355,928,000 barrels, while in 1928 production was over 900,000,000 barrels.

U. S. CRUDE OIL PRODUCTION AND VALUE OF OIL

Year	Production (Thousands of Barrels)	Value at Wells	Year	Production (Thousands of Barrels)	Value at Wells
1859.....	2	\$ 32	1894.....	49,344	\$ 35,522
1860.....	500	4,800	1895.....	52,892	57,632
1861.....	2,114	1,036	1896.....	60,960	58,519
1862.....	3,057	3,210	1897.....	60,476	40,874
1863.....	2,611	8,226	1898.....	55,364	44,193
1864.....	2,116	20,897	1899.....	57,071	64,604
1865.....	2,498	16,460	1900.....	63,621	75,989
1866.....	3,598	13,455	1901.....	69,389	64,417
1867.....	3,347	8,067	1902.....	88,767	71,179
1868.....	3,646	13,217	1903.....	100,461	94,694
1869.....	4,215	23,730	1904.....	117,081	101,175
1870.....	5,261	20,504	1905.....	134,717	84,157
1871.....	5,205	22,591	1906.....	126,494	92,445
1872.....	6,293	21,441	1907.....	166,095	120,107
1873.....	9,894	18,100	1908.....	178,527	129,079
1874.....	10,927	12,648	1909.....	183,171	128,328
1875.....	8,788	7,368	1910.....	209,557	127,900
1876.....	9,133	22,983	1911.....	220,449	134,045
1877.....	13,350	31,789	1912.....	222,935	164,212
1878.....	15,397	18,045	1913.....	248,446	237,121
1879.....	19,914	17,211	1914.....	265,763	214,125
1880.....	26,286	24,601	1915.....	281,104	179,463
1881.....	27,661	23,512	1916.....	300,767	330,900
1882.....	30,350	23,631	1917.....	335,316	522,635
1883.....	23,450	25,740	1918.....	355,928	703,944
1884.....	24,218	20,477	1919.....	378,367	760,266
1885.....	21,859	19,194	1920.....	442,929	1,360,745
1886.....	28,065	20,028	1921.....	472,183	814,745
1887.....	28,283	18,857	1922.....	557,531	895,111
1888.....	27,612	17,950	1923.....	732,407	978,430
1889.....	35,164	26,963	1924.....	713,940	1,022,683
1890.....	45,824	35,365	1925.....	763,743	1,284,960
1891.....	54,293	30,527	1926.....	770,874	1,447,760
1892.....	50,515	25,950	1927.....	901,129	1,172,830
1893.....	48,431	28,932	*1928.....	900,364	†1,080,437

* Preliminary.

† Estimated.

Authority: U. S. Bureau of Mines

MAJOR OIL FIELDS OF THE UNITED STATES

Because of conditions of overproduction during the last few years, a number of prolific oil areas have not been permitted to produce to the capacity of the wells drilled into the sand; and, therefore, a comparison of the production of the various fields at their peak is rendered more or less valueless. The following record is given, however, as a matter of possible interest.

FIELDS WHICH PRODUCED 100,000 BARRELS OR MORE A DAY

Field	State	Peak Production	
		Amount	Date
Bradford.....	Pa. and N. Y.	100,000	Aug. 1881
Spindletop Shallow.....	Texas	over 100,000	1902
Humble.....	Texas	130,000	June 1905
Glenn Pool.....	Oklahoma	115,000	Oct. 1906
Illinois Fields.....	Illinois	108,000	April 1908
Midway.....	California	over 100,000	1914
Cushing.....	Oklahoma	331,000	May 1915
El Dorado.....	Kansas	109,000	Oct. 1, 1917
Burkburnett.....	Texas	108,000	Aug. 18, 1919
Breckenridge.....	Texas	115,000	Jan. 22, 1921
Mexia.....	Texas	153,000	Dec. 1921
Haynesville.....	Louisiana	95,850	March 25, 1922
Huntington Beach.....	California	117,000	March 31, 1923
Tonkawa.....	Oklahoma	114,700	May 26, 1923
Burbank.....	Oklahoma	121,725	July 14, 1923
Santa Fe Springs.....	California	340,000	Aug. 25, 1923
Salt Creek.....	Wyoming	132,000	Sept. 15, 1923
Long Beach.....	California	284,000	Oct. 1923
Powell.....	Texas	354,893	Nov. 13, 1923
Smackover Hy Shallow.....	Arkansas	111,500	May 31, 1924
Smackover Hy Deep.....	Arkansas	390,000	May 25, 1925
Worham.....	Texas	166,000	Jan. 13, 1925
Inglewood.....	California	116,701	Aug. 4, 1925
Panhandle.....	Texas	167,600	Nov. 3, 1926
Spindletop Deep.....	Texas	96,500	Dec. 25, 1926
Seminole.....	Oklahoma	513,900	July 30, 1927
Crane & Upton Cos.....	Texas	137,150	Oct. 1, 1927
Winkler.....	Texas	272,800	May 5, 1928

NOTE.—In some cases the peak production is the average for one day; in others the average for one week.

RAPID DECLINE OF OIL PRODUCTION

One year after reaching peak production, oil fields show, on an average, a falling off in output amounting to about 60 to 66 per cent. Two years after the peak, the average decline is over 70 per cent, and three years after around 80 per cent. Individual fields show as big a decline after the third year as 94 per cent.

Pro-ration agreements, which were in effect in 1928 and which still are in effect in some fields, of course are interfering with the natural decline as recorded previously under severe competitive drilling conditions. It will be noted that the average decline, after three years' production, recorded by eleven fields which came in subsequent to January 1, 1923, was 82 per cent. The Wortham, Texas, field—which recorded a high production of 153,800 barrels daily during the week ended January 17, 1925—was producing only 2200 barrels daily three years later, a decline of 99 per cent. The Powell, Texas, field declined in three years from 315,800 barrels to 24,400 barrels daily, or 92 per cent. The Santa Fe Springs, California, development—which reached its peak toward the end of 1923—showed a decline of 86 per cent in three years; but subsequently deeper drilling opened up large new production.

Eleven outstanding oil fields, coming in subsequent to January 1, 1923, showed one year after the peak of production an average decline of 68 per cent; two years after the peak, an average decline of 75 per cent; and three years after the peak, an average decline of 82 per cent. Eight of these 11 fields showed an average decline one year after the peak of 68 per cent; two years after the peak, 74 per cent; and three years after the peak, 92 per cent.

The following tables show the peak production and decline during three consecutive years for 15 prolific pools, and also the peak production and decline during three consecutive years for major fields coming in subsequent to January 1, 1923. Because of proration agreements in many

of the principal pools since 1927, no effort has been made to record the decline of production in these fields in years subsequent to the attainment of their peak production.

STATEMENT SHOWING PEAK PRODUCTION AND DECLINE DURING FOLLOWING
THREE YEARS FOR FIFTEEN PROLIFIC FIELDS

(Daily Average Production)

	Date of Peak Production	Highest Production (Barrels)	One Year After Peak (Barrels)	% of De- cline	Two Years After Peak (Barrels)	% of De- cline	Three Years After Peak (Barrels)	% of De- cline
Spindletop, Texas (Shallow)	10/02	62,548	20,409	67	4,914	92	3,672	94
Humble, Texas	6/05	93,272	14,962	84	7,686	92	9,618	90
Ranger, Texas	6/10	73,250	25,500	65	17,200	77	22,420	69
Glenn Pool, Okla.	3/11	83,370	29,811	64	26,033	69	28,108	66
Cushing, Okla.	3/15	269,735	92,303	66	71,246	74	52,027	81
Healdton, Okla.	10/15	86,400	57,580	34	58,921	32	36,221	58
Augusta, Kans.*	11/16	75,000	25,000	67	16,000	79	11,000	85
El Dorado, Kans.* . . .	9/17	109,000	81,000	26	47,000	57	41,400	63
Burkburnett, Texas..	8/19	90,000	50,750	44	49,200	46	30,475	66
Desdemona, Texas..	9/19	45,725	12,000	74	5,800	88	3,000	94
Homer, La.	8/20	67,484	28,258	58	15,369	77	10,147	85
El Dorado, Ark.	8/21	66,984	30,677	54	21,192	68	12,800	81
Mexia, Texas	1/22	141,065	56,477	60	36,052	74	25,200	82
Breckenridge, Texas..	1/22	110,806	47,433	57	30,094	67	21,066	81
Haynesville, La.	3/22	87,794	35,121	60	19,087	78	14,500	83
Totals		1,462,433	607,281	58	425,794	71	321,654	78

* All production figures shown are daily averages over a period of a month with the exception of those marked thus (*) which are daily averages over a period of a week.

STATEMENT SHOWING PEAK PRODUCTION AND DECLINE DURING FOLLOWING
THREE YEARS FOR MAJOR FIELDS COMING IN SUBSEQUENT TO JANUARY 1, 1923

(Daily Averages)

Field	Date	Highest Production (Barrels)	One Year After Peak (Barrels)	% of De- cline	Two Years After Peak (Barrels)	% of De- cline	Three Years After Peak (Barrels)	% of De- cline
Huntington								
Beach, Cal.....	7/14/23	126,000	44,500	65	44,000	65	43,500	66
Tonkawa, Okla.....	6/16/23	113,500	35,700	69	58,900	48	34,800	69
Burbank, Okla.....	7/21/23	121,700	85,300	30	56,300	54	44,050	64
Santa Fe Springs, Cal.....	8/25/23	340,000	57,500	83	52,500	85	49,000	86
Long Beach, Cal....	10/27/23	255,000	138,000	46	107,000	58	60,000	76
Powell, Texas.....	11/10/23	315,800	71,150	77	38,850	88	24,400	92
Total (Foregoing Fields).....		1,272,000	432,150	66	357,550	72	255,750	80
Cromwell, Okla.....	8/23/24	63,800	28,550	55	16,450	74	12,350	81
Wortham, Texas....	1/17/25	153,800	12,900	92	5,900	96	2,200	99
Total (Foregoing 8 Fields).....		1,489,600	473,600	68	379,900	74	270,300	92
Smackover (heavy), Ark.....	5/30/25	415,200	134,200	68	89,700	78	60,650	85
Inglewood, Cal.....	8/29/25	109,000	45,000	59	34,000	69	29,500	73
Garber, Okla. ¹	11/21/25	72,150	23,700	67	10,000	86	7,100	90
Total (Foregoing 11 Fields).....		2,085,950	676,500	68	513,600	75	367,550	82
Spindletop, Texas..	12/25/26	96,500	53,500	45	36,550	62	.....	..
Panhandle, Texas..	11/20/26	167,600	82,550	51	66,750	60	.....	..
Seminole, Okla.....	7/30/27	513,900	237,450	²	.....	..	.....	..
Crane & Upton, Texas.....	10/ 1/27	137,150	57,050	³	.....	..	.....	..
Winkler, Texas....	5/ 5/28	272,800	143,000	³	.....	..	.....	..

NOTE.—Figures are daily average for the week ending date indicated.

¹ Garber deep sand production started in 1925.

² Seminole includes Searight, Earlsboro, Bowlegs and Little River. Production was limited by proration agreement.

³ Proration agreements in affect.

OVER THREE HUNDRED THOUSAND PRODUCING OIL WELLS

There are 323,300 (December 31, 1927) producing oil wells in the United States. Some of these wells are yielding oil at a high rate, being flowing wells comparatively recently drilled, that is, wells with " flush " production, while others are wells which are still flowing but whose production has greatly declined since completion and is steadily declining to a point where the wells must be pumped to be commercially productive. Still another class of wells, and this is by far the largest in point of number, are the pumping wells with " settled " production. Usually, after wells are put on the pump, the decline in production is slow, as compared with the rapid decline of flowing wells, and this has caused the production from such wells to be called "settled " production.

The average production per well per day in the United States is 7.7 barrels, based on total production during December 1927, divided by the 323,300 wells which were producing at the end of that month.

In the older fields, where virtually all the wells are pumping wells, the average production per well is in most cases less than one barrel a day. For instance, in Pennsylvania where there are 78,480 producing oil wells, nearly a fourth of the country's total, the wells average less than half a barrel a day. Some of these wells have been producing for many years.

There are a large number of old wells in Oklahoma, which produce little more, or less, than a barrel a day, but Oklahoma also has many wells in new fields producing at a high daily rate. The average production per well per day in the state is 12.3 barrels for 61,750 wells. There are 32,000 wells in Texas, averaging 19.5 barrels a day. The average yield of California wells is relatively high, amounting to 55.9 barrels for 11,280 wells.

PRODUCING OIL WELLS IN THE UNITED STATES, DECEMBER 31, 1927

State	Number of Wells	Average per Well per Day (Barrels)	December 31, 1927	
			Number of Wells	Average per Well per Day
Arkansas.....	4,500	37.2	4,550	24.2
California ¹	11,330	55.0	11,280	55.9
Colorado.....	130	72.2	170	51.7
Illinois.....	16,270	1.3	16,240	1.2
Indiana:				
Southwestern.....	990	1.8	1,100	1.9
Northeastern.....	1,060	.4	960	.3
Total Indiana.....	2,050	1.1	2,060	1.1
Kansas.....	19,230	6.0	19,600	5.8
Kentucky.....	13,300	1.3	13,500	1.4
Louisiana:				
Gulf coast.....	240	45.4	250	56.5
Rest of State.....	3,950	14.0	4,000	12.2
Total Louisiana.....	4,190	16.0	4,250	14.8
Michigan.....	90	5.3	300	6.2
Montana.....	830	29.8	980	15.3
New Mexico.....	230	24.7	250	14.0
New York.....	16,150	.3	16,740	.4
Ohio:				
Central and Eastern.....	21,150	.7	20,100	.8
Northwestern.....	18,100	.3	17,500	.3
Total Ohio.....	39,250	.5	37,600	.5
Oklahoma.....	61,600	8.1	61,750	12.3
Pennsylvania.....	76,800	.3	78,480	.3
Texas:				
Gulf Coast.....	2,520	45.5	2,600	50.3
Rest of State.....	26,510	14.5	29,400	16.7
Total Texas.....	29,030	17.4	32,000	19.5
West Virginia.....	20,150	.8	19,900	.8
Wyoming.....	3,400	21.8	3,560	16.8
Other ²	70	...	90	...
Totals.....	318,600	6.8	323,300	7.7

Authority: U. S. Bureau of Mines.

¹ From American Petroleum Institute.² Alaska, Tennessee, and Utah.

LESS THAN TWO PER CENT OF THE WELLS PRODUCE FIFTY PER CENT OF THE OIL

Less than two per cent of the total number of producing oil wells in the United States are actually producing fifty per cent of the total oil. The approximate number of producing oil wells during March 1929, was 316,073, having a daily average production during the month of 2,657,801 barrels, or a daily average production per well of 8 barrels. More than half of this production is accounted for by 6,024 wells, having a daily average production per well of 232 barrels.

This illustrates the great difference in the productive capacity of the many wells which supply this country's oil needs. While it takes only 6,000 wells to supply half of one month's production, over 300,000 wells were required to supply the other half.

The following is a compilation, the purpose of which is to show the number of wells required to produce certain approximate portions, and the total daily average production, of the United States, during the period covered:

MARCH 1929

Approximate Daily Production (Barrels)	Actual Production (Barrels)	Number of Producing Wells	Average Production Per Well Per Day
500,000	471,816	1,191	396
750,000	747,263	2,197	340
1,000,000	1,073,977	3,689	291
1,100,000	1,135,295	4,015	283
1,200,000	1,199,528	4,409	272
1,300,000	1,299,623	5,135	253
1,400,000	1,400,072	6,024	232
1,500,000	1,505,095	7,271	207
1,600,000	1,600,167	8,572	187
1,700,000	1,702,517	10,750	158
1,800,000	1,806,126	14,076	128
.....	.....	15,800	...
1,900,000	1,899,329	17,631	108
2,000,000	2,001,039	22,197	90
2,100,000	2,103,997	29,059	72
.....	.....	31,610	...
2,200,000	2,207,316	38,150	58
2,300,000	2,294,059	48,095	48
2,400,000	2,407,867	66,354	36
2,500,000	2,501,808	93,960	27
2,600,000	2,657,801	316,073	8
2,700,000	.....	.....	...

Authority: American Petroleum Institute.

WELLS DRILLED SINCE BEGINNING OF INDUSTRY

Since the beginning of the petroleum industry in 1859, 763,095 wells have been drilled for oil and gas in this country. Prior to 1900, the total yearly completions, including dry holes, did not exceed 15,000 wells. Deeper drilling has been the outstanding feature of latter-day production.

NUMBER OF WELLS DRILLED SINCE BEGINNING OF INDUSTRY

UNITED STATES

Year	Total Wells Completed	Year	Total Wells Completed	Year	Total Wells Completed
1859.....	2	1884.....	2,269	1909.....	18,327
1860.....	49	1885.....	2,814	1910.....	14,940
1861.....	78	1886.....	3,583	1911.....	13,768
1862.....	92	1887.....	1,981	1912.....	17,180
1863.....	137	1888.....	2,127	1913.....	25,590
1864.....	226	1889.....	6,507	1914.....	23,137
1865.....	474	1890.....	8,347	1915.....	14,157
1866.....	442	1891.....	5,101	1916.....	24,619
1867.....	618	1892.....	3,771	1917.....	23,407
1868.....	928	1893.....	4,170	1918.....	25,687
1869.....	1,500	1894.....	7,551	1919.....	29,173
1870.....	1,664	1895.....	13,069	1920.....	33,911
1871.....	1,470	1896.....	13,808	1921.....	21,937
1872.....	1,183	1897.....	9,538	1922.....	24,689
1873.....	1,263	1898.....	8,644	1923.....	24,438
1874.....	1,317	1899.....	13,934	1924.....	21,888
1875.....	2,400	1900.....	15,517	1925.....	25,623
1876.....	2,920	1901.....	14,372	1926.....	29,319
1877.....	3,940	1902.....	15,407	1927.....	24,143
1878.....	3,064	1903.....	18,365	1928.....	22,331
1879.....	3,049	1904.....	20,261	Total.....	763,095
1880.....	4,220	1905.....	16,731		
1881.....	3,833	1906.....	19,057		
1882.....	3,307	1907.....	19,872		
1883.....	2,850	1908.....	16,909		

Authorities: U. S. Geological Survey, Bureau of Mines, and *Oil and Gas Journal*.

OVER TWENTY THOUSAND WELLS DRILLED ANNUALLY

According to an old saying in the oil industry, "the only proof of oil production is in the drill," and to supply the demand for oil over twenty thousand wells are drilled annually at a cost running into the hundreds of millions of dollars. During 1928, a total of 22,331 wells were completed, of which 12,526, or 56 per cent, found oil; 2,727, or 12 per cent, found gas; and 7,078, or 32 per cent, were dry.

WELLS DRILLED IN THE UNITED STATES

1908-1928

Year	Wells Completed			
	Oil	Gas	Dry	Total
1908.....	13,210	485	3,214	16,909
1909.....	13,875	1,048	3,404	18,327
1910.....	11,018	1,500	2,422	14,940
1911.....	9,825	1,580	2,363	13,768
1912.....	12,514	1,811	2,855	17,180
1913.....	19,101	2,207	4,282	25,590
1914.....	16,668	2,327	4,142	23,137
1915.....	9,154	2,022	2,981	14,157
1916.....	18,777	1,803	4,039	24,619
1917.....	16,590	1,966	4,851	23,407
1918.....	17,845	2,229	5,613	25,687
1919.....	21,052	2,135	5,986	29,173
1920.....	24,273	2,274	7,364	33,911
1921.....	14,666	2,111	5,160	21,937
1922.....	17,333	2,024	5,332	24,689
1923.....	16,206	2,349	5,883	24,438
1924.....	14,587	2,257	5,044	21,888
1925.....	16,559	2,330	6,734	25,623
1926.....	19,013	2,341	7,965	29,319
1927.....	14,442	2,491	7,210	24,143
1928.....	12,526	2,727	7,078	22,331

Authorities: U. S. Bureau of Mines and *Oil and Gas Journal*

NEARLY ONE-THIRD OF WELLS DRILLED ARE DRY

Nearly one-third of all the wells drilled for oil and gas are dry. In 1928, 32 per cent of all wells completed were dry. Thousands of wells are drilled to completion annually, and the records show that during the last four years failures have averaged over 28 per cent. In addition, many wells which are listed when they come in as producing wells fall off rapidly and fail to maintain commercial production.

PERCENTAGE OF DRY HOLES TO TOTAL OIL AND GAS WELLS COMPLETED

Year	Total Completions	Dry Holes	Per Cent Dry
1908.....	16,909	3,214	19.0
1909.....	18,327	3,404	18.6
1910.....	14,940	2,422	16.2
1911.....	13,768	2,363	17.2
1912.....	17,180	2,855	16.6
1913.....	25,590	4,282	16.7
1914.....	23,137	4,142	17.9
1915.....	14,157	2,981	21.1
1916.....	24,619	4,039	16.4
1917.....	23,407	4,851	20.7
1918.....	25,687	5,613	21.9
1919.....	29,173	5,986	20.5
1920.....	33,911	7,364	21.7
1921.....	21,937	5,160	23.5
1922.....	24,689	5,332	21.6
1923.....	24,438	5,883	24.1
1924.....	21,888	5,044	23.0
1925.....	25,623	6,734	26.3
1926.....	29,319	7,965	27.2
1927.....	24,143	7,210	29.9
1928.....	22,331	7,078	31.7

Authority: U. S. Bureau of Mines.

INITIAL PRODUCTION OF OIL WELLS

When a well is drilled into an oil sand, it usually produces its largest amount immediately upon completion; in other words, the initial production of oil wells represents

the maximum output. The flow of oil usually subsides, either gradually or rapidly as the case may be, after the early production stages. During the last eight years the daily average initial production of wells drilled in the United States has been higher than formerly. In 1928, the initial daily average production per well was 668 barrels, the largest ever recorded; and indicates that new wells completed during the year came in exceptionally large producers.

DAILY AVERAGE INITIAL PRODUCTION OF OIL WELLS COMPLETED

Year	Oil Wells Completed	Daily Average Initial Production (Barrels)	Initial Production Per Well (Barrels)
1916.....	18,777	1,601,170	85
1917.....	16,590	1,511,028	91
1918.....	17,845	1,613,813	90
1919.....	21,052	3,554,486	168
1920.....	24,273	3,508,100	145
1921.....	14,666	2,827,809	193
1922.....	17,333	4,226,119	244
1923.....	16,206	6,105,100	377
1924.....	14,587	3,255,491	223
1925.....	16,559	4,300,356	260
1926.....	19,013	3,683,787	194
1927.....	14,442	4,918,456	340
1928.....	12,526	8,365,778	668

Authority: U. S. Bureau of Mines.

PRODUCTION OF WELLS ON COMPLETION

A classification of well completions, as reported to trade journals, is made by the Mid Continent Oil and Gas Association covering wells completed east of California. This table for 1928 shows 32.7 per cent of wells completed were dry; 19.5 per cent were gas wells; and 25.8 per cent were wells which came in producing 25 barrels or less per day. Less than 5 per cent of the wells came in producing over 1,000 barrels of oil a day.

The Mid Continent Oil and Gas Association also makes a tabulation of No. 1 wells, *i. e.*, the initial or test well on each lease in Kansas and Oklahoma. This shows for 1928 that 65 per cent of the wells came in dry.

CLASSIFICATIONS OF WELL COMPLETIONS
By States and Years, 1920 to 1928, Inclusive (East of California)
(Initial Production per Well in Barrels of 42 Gallons as Reported to Trade Journals)

1928	Dry	Gas	25 Bbls. or Less	26 to 50 Bbls.	51 to 75 Bbls.	76 to 100 Bbls.	101 to 200 Bbls.	201 to 300 Bbls.	301 to 500 Bbls.	501 to 750 Bbls.	751 to 1,000 Bbls.	1,001 to 2,000 Bbls.	Over 2,000 Bbls.	Total
Oklahoma.....	1,229	491	508	241	121	89	231	123	155	145	94	122	128	3,677
Kansas.....	1,459	118	163	100	38	50	117	43	27	19	11	8	4	1,157
Texas (except S. W.).....	2,315	347	831	454	247	193	383	160	140	90	48	142	415	5,765
Gulf Coast & S. W. Texas.....	995	159	207	122	54	77	146	64	81	48	74	106	41	2,174
Louisiana-Arkansas.....	311	257	36	40	18	19	28	13	13	7	4	11	13	893
Rocky Mountain Fields.....	417	84	109	87	44	39	54	26	18	7	5	7	3	794
Eastern Fields.....	560	1,065	2,928	87	32	17	45	18	4	2	0	0	0	4,748
Lima-Indiana.....	140	69	135	51	10	7	6	0	4	0	0	1	0	414
Illinois-Michigan.....	87	38	63	45	12	17	14	7	7	3	1	3	1	298
Ky., Tenn., Miss., Ala., Ga., Fla.....	454	55	512	190	62	72	58	11	4	0	1	0	0	1,419
Total.....	6,957	2,664	5,512	1,417	638	580	1,082	465	453	321	238	400	605	21,342
Per cent.....	32.7	12.5	25.5	6.6	3.0	2.7	5.1	2.2	2.1	1.5	1.1	1.9	2.8	100.0
1927—Total.....	7,008	2,472	6,267	1,643	741	688	1,228	546	542	354	292	494	551	22,826
Per Cent.....	30.7	10.8	27.5	7.2	3.2	3.0	5.4	2.4	2.4	1.5	1.3	2.2	2.4	100.0
1926—Total.....	7,778	2,344	8,131	2,571	1,331	1,153	1,907	745	663	299	241	323	305	27,791
Per Cent.....	28.0	8.4	29.3	9.3	4.8	4.1	6.9	2.7	2.4	1.0	0.9	1.1	1.1	100.0
1925—Total.....	6,490	2,359	6,678	2,141	985	866	1,569	727	687	333	295	409	385	23,924
Per Cent.....	27.1	9.9	27.9	9.0	4.1	3.6	6.6	3.0	2.9	1.4	1.2	1.7	1.6	100.0
1924—Total.....	5,138	2,303	5,850	1,697	857	879	1,461	663	671	261	251	338	230	20,599
Per Cent.....	24.9	11.2	28.4	8.2	4.2	3.8	7.1	3.2	3.3	1.3	1.2	1.6	1.1	100.0
1923—Total.....	5,974	2,393	7,104	1,766	945	881	1,464	710	624	307	309	503	520	23,500
Per Cent.....	25.5	10.2	30.2	7.5	4.0	3.8	6.2	3.0	2.7	1.3	1.3	2.1	2.2	100.0
1922—Total.....	5,883	2,021	8,135	1,699	816	851	1,550	683	705	360	374	495	378	23,950
Per Cent.....	24.6	8.4	34.0	7.1	3.4	3.6	6.5	2.8	2.9	1.5	1.5	2.1	1.6	100.0
1921—Total.....	5,929	2,087	6,955	1,590	715	769	1,092	583	628	274	260	314	196	21,392
Per Cent.....	27.7	9.8	32.5	7.4	3.3	3.6	5.1	2.7	3.0	1.3	1.2	1.5	0.9	100.0
1920—Total.....	7,972	2,249	12,480	2,997	1,274	1,348	1,918	1,048	798	368	284	252	172	33,160
Per Cent.....	24.0	6.8	37.6	9.0	3.8	4.1	5.8	3.2	2.4	1.1	0.9	0.8	0.5	100.0
GRAND TOTAL, 9 Years, 1920 to 1928, inclusive.....	59,139	20,892	67,112	17,521	8,302	8,015	13,271	6,170	5,771	2,877	2,544	3,528	3,342	218,494
Per Cent.....	27.1	9.6	30.7	8.0	3.8	3.7	6.1	2.8	2.6	1.3	1.2	1.6	1.5	100.0

Authority: Mid Continent Oil and Gas Association

TABULATION OF NO. 1 WELLS IN KANSAS AND OKLAHOMA

(The Initial or Test Well on Each Lease)

	Kansas			Oklahoma			Totals		
	Dry & Gas	Oil	Percent Non-Oil	Dry & Gas	Oil	Percent Non-Oil	Dry & Gas	Oil	Percent Non-Oil
1928—									
January	49	19	72.1	86	41	67.7	135	60	69.2
February	34	17	66.7	90	40	69.2	124	57	68.5
March	42	24	63.6	64	51	55.7	106	75	58.6
April	40	15	72.7	121	60	66.9	161	75	68.2
May	20	6	76.9	99	47	67.8	119	53	69.2
June	37	15	71.2	71	45	61.2	108	60	64.3
July	48	11	81.4	100	59	62.9	148	70	67.9
August	38	18	67.9	66	49	57.4	104	67	60.8
September	21	15	58.3	77	62	55.4	98	77	56.0
October	37	9	80.4	92	61	60.1	129	70	64.8
November	47	17	73.4	72	37	66.1	119	54	68.8
December	23	8	74.2	63	47	57.3	86	55	61.0
Total—1928	436	174	71.5	1,001	599	62.6	1,437	773	65.0
1927—									
January	55	16	77.5	112	66	63.0	167	82	67.1
February	44	13	77.2	71	62	53.4	115	75	60.5
March	55	20	73.3	92	60	60.5	147	80	64.8
April	56	23	69.6	111	74	60.0	167	97	63.3
May	42	12	77.8	110	70	61.1	152	82	65.0
June	53	20	72.6	84	64	56.8	137	84	62.0
July	84	19	81.6	104	68	60.5	188	87	68.4
August	30	11	73.2	93	62	60.0	123	73	62.8
September	36	21	63.2	86	56	60.6	122	77	61.3
October	26	16	60.9	100	62	61.7	26	78	61.8
November	42	27	60.9	81	50	61.8	123	77	61.5
December	17	13	56.7	71	40	64.0	88	53	62.4
Total—1927	540	211	71.9	1,115	734	60.3	1,655	945	63.7
Total—1926	599	260	69.7	1,243	637	66.1	1,842	897	67.3
Total—1925	511	258	66.4	1,154	592	66.1	1,655	850	66.1
Total—1924	339	162	67.7	982	680	59.1	1,321	842	61.1
Total—1923	444	182	70.9	1,283	796	61.7	1,737	978	64.0
Total—1922	354	223	61.4	1,023	811	55.8	1,377	1,034	57.1
Total—1921	301	206	59.4	1,227	794	60.7	1,528	1,000	60.4
Total—1920	466	346	57.4	1,497	1,174	56.0	1,963	1,520	56.4
Grand total— 9 years	3,990	2,022	66.4	10,525	6,817	60.7	14,515	8,839	62.1
1920 to 1928 inclusive.									

Authority: Mid Continent Oil & Gas Association

GOVERNMENT AND INDIAN OIL LANDS

The Federal Government is the owner of areas embracing several hundred million acres of land, the title to which is really held in trust for the public generally. Within these areas are proved oil fields and also much tested territory, holding in varying degrees promise of oil in commercial quantities.

Oil lands on the Public Domain are leased in accordance with the provisions of the leasing act of March 3, 1921.

However, President Hoover on March 12, 1929, announced that "there will be no leases or disposal of government oil lands, no matter what category they may lie in, of government holdings or government controls, except those which may be mandatory by Congress. In other words, there will be complete conservation of government oil by this administration." (See Appendix: Conservation of Petroleum.)

Statistics relating to the production of petroleum, natural gas and natural gasoline under government lease, permit, and license involving public land are summarized in the following tables:

PETROLEUM PRODUCED FROM PUBLIC LANDS

Fiscal year	Production (Barrels)	Royalty oil (Barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
1921-1925.....	118,333,954.01	21,884,217.52	\$32,938,494.47	\$398,543.30	\$251,197.70	\$33,588,235.47
1926.....	29,712,876.16	4,431,563.63	7,951,665.52	93,508.29	154,265.43	8,199,439.24
1927.....	25,648,101.43	3,562,124.54	5,741,485.97	91,796.54	173,172.59	6,006,455.10
1928.....	23,370,549.38	3,142,027.63	3,519,810.55	108,570.86	107,070.00	3,735,451.41
	197,065,480.98	33,019,933.32	50,151,456.51	692,418.99	685,705.72	51,529,581.22

1928, by States

State	Production (Barrels)	Royalty oil (Barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
California.....	6,334,748.72	818,731.50	\$649,039.95	\$3,000.61	\$22,606.78	\$674,647.34
Colorado.....	921,640.81	74,270.82	48,229.73	3,292.25	109.45	51,631.43
Louisiana.....	9,509.01	973.00	1,749.58	1,868.24	211.39	3,829.21
Montana.....	768,285.87	44,634.02	75,923.93	2,009.32	.....	77,933.25
New Mexico.....	72,383.96	12,618.56	12,054.11	1,187.00	7.74	13,248.85
Oklahoma.....	602,165.40	95,079.98	144,168.50	.....	3,805.75	147,974.25
Utah.....	2,254.83	315.64	430.64	4,353.36	.....	4,784.00
Wyoming.....	14,659,560.78	2,095,404.11	2,588,214.11	92,860.08	80,328.89	2,761,403.08

In addition to the accrued royalties shown above, bonuses on sale of oil leases amounted to \$672,000 in California and \$500 in Wyoming in 1928.

Authority: U. S. Geological Survey

In addition to production from public lands, there is the production of petroleum, natural gas and natural gasoline from Naval Petroleum Reserves No. 1 and 2, in California, and No. 3, in Wyoming, which is shown in the following tables:

PETROLEUM PRODUCED FROM NAVAL RESERVES

Total

Fiscal year	Production (Barrels)	Royalty (Barrels)	Royalty value			
			Oil	Gas	Gasoline	Total
1921-1925	40,406,158.14	9,381,761.48	\$10,685,660.38	\$298,874.65	\$231,485.45	\$11,216,020.48
1926	12,755,382.16	2,779,100.13	3,310,658.54	114,247.75	152,480.36	3,577,386.65
1927	12,725,365.02	2,902,243.85	3,175,882.25	110,204.62	169,643.75	3,455,730.62
1928	9,839,859.19	2,303,557.85	1,933,880.81	133,819.74	164,674.84	2,232,375.39
	75,726,764.51	17,366,663.31	19,106,081.98	657,146.76	718,284.40	20,481,513.14

1928, by States

California:						
1921-1925...	9,690,573.93	2,284,897.18	\$1,909,711.11	\$125,866.88	\$162,834.08	\$2,198,412.07
Wyoming:						
1922-1927...	3,400,942.37	465,668.33	763,114.40	44,765.64	7,104.55	813,984.59
1928.....	149,285.26	18,660.67	24,169.70	7,952.86	1,840.76	33,963.32

Authority: U. S. Geological Survey

OIL INDUSTRY ON INDIAN RESERVATIONS

Oil has been discovered on a number of Indian Reservations, notably in Oklahoma. One of the richest oil areas in the United States is found in the Osage Nation in Oklahoma and belongs to the Osage Tribe of Indians. These lands were purchased in June 1883 by the Osages from the Cherokee Indians, at a price of \$1.25 per acre. The Cherokees, at the time of the sale, thought they had made a fine bargain. The Osages were allotted the surface of the lands individually, but the mineral rights were reserved for the benefit of the tribe collectively. Hence the members share equally in oil royalties and bonuses. Each enrolled Osage Indian, in the fiscal year 1928, received from the government approximately \$5,700. Some families receive as high as \$112,000, derived largely from oil royalties and bonuses. In addition to this, under the terms of the leases, the Osage Indians

receive one-fifth or one-sixth royalties, depending upon the capacity of the wells.

The Indians of the five civilized tribes—Cherokee, Choctaw, Chickasaw, Creek and Seminole Indians—did not reserve to the tribe the mineral rights when allotments were made. Therefore, some Indians have received lands on which tremendous sums in royalties from oil production have been paid, while others received only agricultural lands. Some of the Creek Indians in Oklahoma have received as high as 50,000 a year from oil royalties.

Oil has also been discovered or developed in the Pawnee, Otoe and Kiowa Reservations in Oklahoma; the Crow Reservation, in Montana; the Shoshone Reservation, in Wyoming, and the Ute Reservation in Colorado. Sales of leases and development of oil have also occurred on the Navajo Indian Reservation in New Mexico.

PER CAPITA BONUS PAYMENTS TO THE OSAGES

Year Ending June 30	Number of Payments	Amount of Each Share	Total Amount
1916	4	\$ 384.93	\$ 858,008.97
1917	6	2,719.98	6,062,835.42
1918	6	3,672.33	8,185,623.57
1919	7	3,930.00	8,759,970.00
1920	9	8,090.00	18,032,610.00
1921	7	8,600.00	19,169,400.00
1922	4	7,700.00	17,163,300.00
1923	4	12,400.00	27,639,600.00
1924	4	11,600.00	25,856,400.00
1925	3	9,300.00	20,729,700.00
1926	5	13,400.00	29,868,600.00
1927	4	7,700.00	17,163,300.00
1928	4	5,900.00	12,705,300.00

NOTE.—The above tabulation does not include interest in trust funds in the U. S. Treasury, which is also paid out quarterly and amounts to \$47.75 to each enrolled Osage who has not withdrawn any part of such trust funds. And it does not include miscellaneous receipts.

Authority: Office of Indian Affairs, Department of Interior.

OSAGE OIL DEVELOPMENT

Auctions of Osage Indian Reservation oil and gas leases have been held periodically since 1912. Under the prescribed method of development, oil companies and individuals bid against each other in the payment of bonuses for the leases; that is, for the privilege of drilling wells. The individual tracts offered are of 160 acres each, and bonuses as high as \$1,900,000 have been paid for one tract. In addition to these bonuses, the members of the Osage Tribe receive royalties of one-fifth or one-sixth of the oil produced.

All oil, gas and other minerals are reserved to the Osage Tribe as a unit until April 8, 1946, under Section 3 of the Osage Allotment Act, approved June 26, 1906, as amended by the Act of March 3, 1921; and leases for mining such minerals are made through the Osage Tribal Council with the approval of the Secretary of the Interior under current regulations, promulgated March 7, 1923 as to oil and gas, and November 1, 1919 as to other minerals. The amendment above mentioned to the Allotment Act directs the Secretary of the Interior and the Osage Council to offer for lease for oil and gas mining purposes, prior to April 8, 1931, the unleased portion of the Reservation, which approximated one million acres on the date when the Act became a law. Up to the present time, thirty lease sales have been held in which 1,235,845 acres were offered.

All leases provide for one-sixth royalty, except where the wells on any quarter-section, or fractional quarter-section (if the land covered by the lease does not include the full quarter-section) during any calendar month, is sufficient to average 100 or more barrels per well per day, when the royalty on such oil is one-fifth.

OSAGE OIL LEASE SALES AND BONUSES

Date of Sale	Acres Offered	Acres Sold	Bonus Offered	Average
Nov. 11, 1912.....	107,594	24,541	\$ 39,436.00	\$1.60
Sept. 29, 1913.....	12,049	10,132	498,182.58	49.17
Apr. 20, 1916.....	17,280	14,377	2,057,600.00	143.11
June 20, 1916.....	3,020	2,482	1,169,280.78	471.10
May 31, 1917.....	9,120	8,160	1,947,600.00	238.67
Nov. 12, 1917.....	20,621	19,869	1,677,200.00	84.42
Feb. 14, 1918.....	32,160	25,440	1,275,500.00	50.14
May 18, 1918.....	51,400	38,890	1,180,575.00	30.29
Nov. 9, 1918.....	43,040	34,720	3,350,200.00	96.49
Mar. 5, 1919.....	21,000	20,520	2,790,925.00	136.01
June 6, 1919.....	39,251	38,451	3,884,925.00	101.04
Oct. 6, 1919.....	35,310	34,670	6,056,950.00	174.70
Feb. 3, 1920.....	31,613	29,533	3,102,700.00	105.05
May 18, 1920.....	31,783	31,303	2,851,900.00	91.10
Oct. 12, 1920.....	36,877	36,877	3,993,750.00	108.30
June 14, 1921.....	26,588.7	25,918.7	4,559,100.00	175.90
Dec. 12, 1921.....	36,414.4	35,665.1	7,261,600.00	203.60
Mar. 2, 1922.....	37,184.2	33,467.5	3,949,950.00	118.02
June 28, 1922.....	34,660.15	33,220.15	10,889,700.00	327.80
Jan. 18, 1923.....	33,913.88	24,071.24	6,217,500.00	256.29
Apr. 5, 1923.....	33,790.34	23,640	8,029,100.00	339.64
Mar. 18-19, 1924.....	100,305.38	50,982.24	14,193,300.00	278.40
June 30, 1924.....	19,785.41	11,145.41	2,250,200.00	201.89
Dec. 18, 1924.....	29,889.73	8,609.73	1,087,300.00	126.00
Mar. 18, 1925.....	35,227.98	12,205.07	671,650.00	55.03
Mar. 17-18, 1926.....	113,392.04	46,331.45	3,998,485.00	86.30
Sept. 30, 1926.....	35,780.72	15,520	2,117,300.00	136.42
Mar. 28, 1927.....	74,564.31	20,656.16	2,435,700.00	117.92
Dec. 12, 1927.....	20,000	18,720	2,267,550.00	121.12
Mar. 28-29, 1928.....	92,229.67	63,440.90	2,437,300.00	38.42
Total.....	1,235,844.91	793,648.65	108,242,459.36	

Authority: Office of Indian Affairs, Department of Interior.

OSAGE OIL AND GAS PRODUCTION AND ROYALTIES

Year Ended June 30	Gross Oil Production Barrels	Oil, Gas, and Gasoline Royalties
1901.....	10,536	\$ 603.25
1902.....	10,522	448.26
1903.....	52,217	2,957.71
1904.....	90,806	9,713.74
1905.....	1,868,260	128,897.12
1906.....	4,514,004	228,267.34
1907.....	5,547,167	301,580.48
1908.....	4,775,289	246,795.86
1909.....	4,816,462	248,013.53
1910.....	5,091,424	233,991.45
1911.....	9,418,769	517,691.21
1912.....	9,445,669	656,176.47
1913.....	7,787,030	778,300.22
1914.....	11,091,791	1,358,392.08
1915.....	7,257,788	524,252.52
1916.....	9,805,477	1,097,854.71
1917.....	9,943,919	3,417,815.95
1918.....	10,906,376	4,602,799.75
1919.....	12,138,086	5,420,674.71
1920.....	17,077,348	9,052,551.78
1921.....	20,621,614	11,308,746.20
1922.....	28,941,934	9,235,691.80
1923.....	41,810,178	14,072,541.61
1924.....	37,577,900	11,879,496.15
1925.....	33,662,179	11,144,492.63
1926.....	25,682,848	10,349,864.76
1927.....	25,884,734	10,386,837.61
1928.....	21,741,225	6,032,177.05
Total.....	367,571,552	113,237,625.95

Authority: Office of Indian Affairs, Department of Interior.

GROSS PRODUCTION OF OIL BY FIELDS

The following tables are compiled from weekly gross production estimates issued by the American Petroleum Institute:

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
OKLAHOMA				
North Braman.....	1,064,200	2,900	1,875,450	5,150
South Braman.....	576,400	1,550	1,153,200	3,150
Blackwell.....	1,289,650	3,500	1,426,000	3,900
Hubbard.....	989,050	2,700	1,985,050	5,450
Thomas.....	487,350	1,350	1,072,100	2,950
Tonkawa.....	4,939,800	13,500	7,707,000	21,100
Garber.....	3,129,650	8,550	5,056,150	13,850
Burbank.....	11,962,950	32,700	15,223,100	41,700
Osage (outside Burbank)...	10,236,200	27,950	11,896,000	32,600
Watchhorn.....	163,100	450	777,550	2,150
Cushing.....	7,452,900	20,350	7,776,000	21,300
Yale—Jennings.....	3,023,750	8,250	3,940,350	10,800
Davenport.....	729,650	2,000	1,177,450	3,200
Bristow Slick.....	8,195,250	22,400	9,548,850	26,150
North Okmulgee.....	5,527,800	15,100	6,095,800	16,700
Lyons—Deaner.....	2,209,600	6,050	1,890,200	5,200
Stroud.....	197,050	550	493,650	1,350
Cromwell.....	3,460,050	9,450	4,595,050	12,600
Papoose.....	1,626,300	4,450	2,471,950	6,750
Wewoka.....	2,436,450	6,650	6,190,600	16,950
Seminole.....	18,345,950	50,100	80,603,750	220,850
Bowlegs.....	23,987,900	65,550	12,132,050	33,250
Searight.....	5,211,150	14,250	2,544,850	6,950
Little River.....	24,790,650	67,750	3,997,350	10,950
Earlsboro.....	33,375,750	91,200	37,209,650	101,950
Duncan District.....	2,650,150	7,250	2,520,150	6,900
Graham.....	1,995,550	5,450	2,742,950	7,500
Fox.....	611,650	1,650	686,450	1,900
Healdton.....	5,121,750	14,000	5,424,250	14,850
Hewitt.....	3,345,150	9,150	3,604,500	9,900
Scholem Alechem.....	5,250,250	14,350	5,353,350	14,650
Pearson.....	597,700	1,650	.....	.....
St. Louis.....	18,289,900	49,950	.....	.....
Allen Dome.....	4,527,800	12,350	.....	.....
Maud.....	450,800	1,250	.....	.....
Others.....	24,161,750	66,000	24,187,850	66,250
Total.....	242,411,000	662,300	273,358,650	748,900

GROSS PRODUCTION OF OIL BY FIELDS—(Continued)

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
KANSAS				
Greenwood Co.....	10,302,050	28,150	13,421,250	36,750
Florence-Covert.....	434,500	1,200	627,300	1,700
Peabody-Elbing.....	1,264,400	3,450	1,397,500	3,850
Eldorado-Towanda.....	4,945,100	13,500	5,015,600	13,750
Augusta-Fox Bush.....	1,356,750	3,700	1,617,350	4,450
Rainbow Bend.....	579,900	1,600	878,150	2,400
Russell.....	1,261,750	3,450	1,060,400	2,900
Churchill.....	3,798,250	10,350	5,499,150	15,050
Oxford.....	4,338,100	11,850	.....	.....
Others.....	9,947,900	27,200	10,854,150	29,750
Total.....	38,228,700	104,450	40,370,850	110,600
PANHANDLE TEXAS				
Hutchinson Co.....	13,794,950	37,700	32,990,300	90,400
Carson Co.....	2,472,350	6,750	3,278,550	9,000
Gray Co.....	7,816,700	21,350	4,095,850	11,200
Wheeler Co.....	346,700	950	699,650	1,900
Others.....	302,550	850	27,000	100
Total.....	24,733,250	67,600	41,091,350	112,600
NORTH TEXAS				
Burkburnett.....	3,992,500	10,900	4,807,950	13,200
Electra.....	4,607,600	12,600	4,926,100	13,500
Iowa Park & K. M. A.....	1,180,050	3,200	1,186,650	3,250
Wilbarger.....	8,004,950	21,900	4,734,050	12,950
Archer.....	7,402,550	20,250	10,336,450	28,300
Montague-Cook.....	4,254,900	11,600	5,435,850	14,900
Others.....	226,250	600	297,900	800
Total.....	29,668,800	81,050	31,724,950	86,900
WEST CENTRAL TEXAS				
Stephens Co.....	2,748,900	7,500	3,267,450	8,950
Eastland Desdemona.....	2,781,950	7,600	2,793,000	7,650
Brown Co.....	4,503,500	12,300	9,222,350	25,250
Coleman Co.....	978,950	2,650	472,350	1,300
Callahan Co.....	1,363,450	3,750	1,619,700	4,450
Shackelford Co.....	3,433,850	9,400	3,506,600	9,600
Young Co.....	3,062,400	8,350	3,374,750	9,250
Throckmorton Co.....	343,900	950	866,750	2,400
Palo Pinto Co.....	160,050	450	456,850	1,250
Jack Co.....	539,950	1,450	.....	.....
Others.....	232,400	650	660,700	1,800
Total.....	20,149,300	55,050	26,240,500	71,900

GROSS PRODUCTION OF OIL BY FIELDS—(Continued)

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
WEST TEXAS				
Jones Co.....	886,650	2,400	814,350	2,250
Mitchell and Scurry Co....	1,106,550	3,050	1,342,600	3,700
Howard Co.....	4,802,800	13,100	1,152,850	3,150
Reagan Co.....	6,855,700	18,750	9,378,350	25,700
Crane and Upton Co.....	25,741,650	70,350	31,564,550	86,500
Crockett Co.....	994,100	2,700	626,650	1,700
Pecos Co.....	22,108,700	60,400	5,302,150	14,500
Winkler Co.....	57,204,350	156,300	2,976,050	8,150
Others.....	652,700	1,800	638,750	1,750
Total.....	120,353,200	328,850	53,796,300	147,400
EAST CENTRAL TEXAS				
Mexia.....	2,565,800	7,000	3,714,500	10,200
Currie.....	189,650	500	227,850	600
Richland.....	196,650	550	349,350	950
Wortham.....	652,750	1,800	1,252,050	3,450
Corsicana-Powell.....	4,011,250	10,950	6,263,750	17,150
Nigger Creek.....	411,950	1,150	1,491,700	4,100
Others.....	297,950	800	.....	.....
Total.....	8,326,000	22,750	13,299,200	36,450
SOUTHWEST TEXAS				
Luling.....	4,910,050	13,400	6,053,650	16,600
Lytton Springs.....	456,550	1,250	743,200	2,050
Somerset.....	266,000	700	418,050	1,150
Laredo District.....	2,795,500	7,650	4,374,050	12,000
Dale.....	365,100	1,000	44,100	100
Piedras Pintas.....	.....	.....	26,750	50
Salt Flat.....	215,300	600	.....	.....
Others.....	251,100	700	216,250	600
Total.....	9,259,600	25,300	11,876,050	32,550

GROSS PRODUCTION OF OIL BY FIELDS—(Continued)

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
NORTH LOUISIANA				
Homer.....	1,578,900	4,300	1,818,700	5,000
Haynesville.....	2,223,800	6,100	2,755,850	7,550
Caddo Light.....	3,661,400	10,000	4,436,100	12,150
Caddo Heavy.....	1,246,200	3,400	1,690,550	4,600
De Soto—Red River.....	1,500,150	4,100	1,512,550	4,150
Elm Grove.....	208,050	550	243,050	650
Bellevue.....	339,900	950	495,200	1,350
Cotton Valley.....	745,250	2,050	2,059,750	5,650
Urania.....	2,576,450	7,000	3,633,300	9,950
Pleasant Hill.....	219,050	600	172,950	500
Cotton Valley (heavy).....	1,063,750	2,900	.....	.....
Total.....	15,362,900	41,950	18,818,000	51,550
ARKANSAS				
Eldorado.....	1,913,550	5,250	2,200,150	6,050
Smackover (light).....	2,834,500	7,750	3,943,800	10,800
Smackover (heavy).....	21,905,850	59,850	31,624,600	86,650
Stephens.....	384,200	1,050	478,850	1,300
Nevada.....	576,650	1,600	788,750	2,150
Lisbon.....	758,350	2,050	1,394,650	3,800
Champagnolle.....	3,680,850	10,050	.....	.....
Others.....	37,650	100	52,800	150
Total.....	32,091,600	87,700	40,483,600	110,900
COASTAL TEXAS				
West Columbia.....	2,946,550	8,050	3,574,500	9,800
Damon Mound.....	363,150	1,000	336,650	950
Big Creek.....	837,600	2,300	1,264,650	3,450
Boling.....	829,100	2,250	772,000	2,100
Blue Ridge.....	2,303,100	6,300	1,188,950	3,250
Pierce Junction.....	3,980,400	10,850	3,115,800	8,550
Humble.....	684,150	1,850	1,135,000	3,100
Goose Creek.....	2,552,950	6,950	2,953,900	8,100
South Liberty.....	1,437,650	3,950	1,139,650	3,150
Hull.....	4,166,850	11,400	5,977,050	16,400
Saratoga.....	379,200	1,050	409,000	1,100
Batson.....	498,550	1,350	517,250	1,400
Sour Lake.....	1,235,350	3,400	1,629,900	4,450
Spindletop.....	14,020,950	38,300	21,265,300	58,250
Orange Co.....	1,473,100	4,000	1,841,900	5,050
Barber's Hill.....	323,000	900	.....	.....
Sugarland.....	270,950	750	.....	.....
Others.....	1,041,050	2,850	1,562,500	4,300
Total.....	39,343,650	107,500	48,684,000	133,400

GROSS PRODUCTION OF OIL BY FIELDS—(Continued)

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
COASTAL LOUISIANA				
Vinton.....	1,637,950	4,450	1,889,800	5,200
Lockport.....	1,493,500	4,100	2,045,250	5,600
Evangeline.....	371,050	1,000	416,350	1,150
Edgerly.....	431,250	1,200	540,950	1,500
Sorrento Dome.....	277,300	750	.....	.....
East Hackberry.....	1,181,050	3,250	.....	.....
Sweet Lake.....	677,750	1,850	.....	.....
Sulphur Dome.....	801,050	2,200	.....	.....
Others.....	733,900	2,000	596,500	1,600
Total.....	7,604,800	20,800	5,488,850	15,050
Total Gulf Coast.....	46,948,450	128,300	.....	.....
EASTERN				
Eastern.....	40,315,500	110,150	40,471,000	110,900
WYOMING				
Salt Creek.....	14,195,950	38,800	14,605,750	40,000
Grass Creek.....	890,650	2,450	975,550	2,700
Elk Basin.....	377,350	1,050	344,350	950
Big Muddy.....	980,350	2,700	1,036,050	2,850
Lost Soldier.....	1,419,300	3,850	1,148,500	3,150
Rock River.....	935,900	2,550	1,008,100	2,750
Lance Creek.....	205,100	550	274,800	750
Teapot Dome.....	.....	.....	279,900	750
Oregon Basin.....	521,350	1,400	.....	.....
Others.....	1,872,750	5,100	1,316,250	3,600
Total.....	21,398,700	58,450	20,989,250	57,500
MONTANA				
Cat Creek.....	617,950	1,700	799,400	2,200
Sunburst.....	3,163,150	8,650	4,253,100	11,650
Pondera.....	140,950	350	.....	.....
Others.....	70,650	200	69,100	200
Total.....	3,992,700	10,900	5,121,600	14,050
COLORADO				
Moffat (Craig).....	457,650	1,250	676,800	1,850
Fort Collins.....	976,600	2,700	1,234,750	3,350
Florence.....	425,500	1,150	285,700	800
Others.....	789,000	2,150	528,750	1,450
Total.....	2,648,750	7,250	2,726,000	7,450

GROSS PRODUCTION OF OIL BY FIELDS—(Continued)

	1928		1927	
	Total Barrels	Daily Average Barrels	Total Barrels	Daily Average Barrels
NEW MEXICO				
Table Mesa.....	44,100	100	82,350	200
Hogback.....	166,900	450	395,350	1,100
Artesia.....	419,750	1,150	434,950	1,200
Rattlesnake.....	246,000	700	336,600	900
Others.....	68,100	200	10,850	50
Total.....	944,850	2,600	1,260,100	3,450
Total Rocky Mt.....	28,985,000	79,200	.....	.....
CALIFORNIA				
Santa Fe Springs.....	16,022,900	43,800	15,140,000	41,500
Long Beach.....	62,530,500	170,850	34,656,500	94,950
Huntington Beach.....	19,998,300	54,650	26,414,500	72,350
Torrance.....	6,484,300	17,700	8,268,500	22,650
Dominguez.....	4,220,000	11,550	5,941,700	16,300
Rosecrans.....	2,325,700	6,350	3,556,200	9,750
Inglewood.....	10,676,400	29,150	12,793,700	35,050
Midway Sunset.....	27,537,500	75,250	31,864,000	87,300
Ventura Ave.....	18,834,100	51,450	17,912,600	49,050
Seal Beach.....	12,413,100	33,900	16,446,000	45,050
Others.....	51,501,900	140,700	58,461,700	160,150
Total.....	232,544,700	635,350	231,455,400	634,100

Authority: American Petroleum Institute

PRODUCTION OF CRUDE OIL IN THE UNITED STATES, BY STATES
(Thousands of Barrels of 42 U. S. Gallons)

U.S.G.S.

Year	New York	Penn- sylvania	West Virginia	Ken- tucky	Ohio	Indiana	Illinois	Kansas	Okl- ahoma	Texas	Wyo- ming	Colo- rado	Cali- fornia	Louis- iana	Ten- nessee	Mon- tana	Arkan- saw	Others	Total United States
1859	2	500	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2 500
1860	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,114
1861	.....	2,114	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,114
1862	.....	3,057	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,057
1863	.....	2,611	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,611
1864	.....	2,116	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,116
1865	.....	2,498	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	2,498
1866	.....	3,598	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,598
1867	.....	3,347	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,347
1868	.....	3,646	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	3,646
1869	.....	4,215	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	4,215
1870	.....	5,261	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,261
1871	.....	5,205	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	5,205
1872	.....	6,293	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	6,293
1873	.....	9,894	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	9,894
1874	.....	10,927	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	10,927
1875	.....	8,788	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	8,788
1876	.....	8,969	120	.....	32	.....	.....	.....	.....	.....	.....	.....	12	.....	.....	.....	.....	.....	9,133
1877	.....	13,135	172	.....	30	.....	.....	.....	.....	.....	.....	.....	13	.....	.....	.....	.....	.....	13,360
1878	.....	13,164	180	.....	38	.....	.....	.....	.....	.....	.....	.....	15	.....	.....	.....	.....	.....	13,397
1879	.....	13,685	180	.....	29	.....	.....	.....	.....	.....	.....	.....	20	.....	.....	.....	.....	.....	13,914
1880	.....	26,023	179	.....	39	.....	.....	.....	.....	.....	.....	.....	40	.....	.....	.....	.....	.....	26,286
1881	.....	27,376	151	.....	34	.....	.....	.....	.....	.....	.....	.....	100	.....	.....	.....	.....	.....	27,661
1882	6,635	23,368	128	.....	40	.....	.....	.....	.....	.....	.....	.....	129	.....	.....	.....	.....	.....	30,350
1883	4,004	19,125	128	5	47	.....	.....	.....	.....	.....	.....	.....	143	.....	.....	.....	.....	.....	23,450
1884	3,231	20,541	90	4	90	.....	.....	.....	.....	.....	.....	.....	262	.....	.....	.....	.....	.....	24,218
1885	2,658	18,118	91	5	662	.....	.....	.....	.....	.....	.....	.....	325	.....	.....	.....	.....	.....	21,859
1886	2,151	23,647	102	5	1,782	.....	.....	.....	.....	.....	.....	.....	377	.....	.....	.....	.....	.....	28,065
1887	2,075	20,281	145	5	5,023	.....	.....	.....	.....	.....	.....	.....	678	.....	.....	.....	.....	.....	28,283
1888	.....	16,439	119	5	10,011	.....	.....	.....	.....	.....	.....	.....	298	.....	.....	.....	.....	.....	27,612
1889	1,897	19,591	544	5	12,472	33	2						317						35,164
1890		28,458	493	6	16,125	64	1	1					307						45,824

FACTS AND FIGURES

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1891	1,585	31,424	2,406	9	17,740	137	^a	2	...	...	666	324	...	...	...	54,293
1892	1,273	27,149	3,810	7	16,363	698	1	5	...	...	824	385	...	...	...	50,515
1893	1,032	19,283	8,446	3	16,249	2,335	1	18	...	...	594	470	...	...	...	48,431
1894	942	18,078	8,577	2	16,792	3,089	...	40	...	...	...	706	...	...	...	49,344
1895	913	18,231	8,120	2	19,545	4,386	...	44	...	...	438	1,209	...	...	...	52,892
1896	1,205	19,379	10,020	2	23,941	4,881	...	114	...	...	...	...	...	...	...	60,960
1897	1,279	17,983	13,090	...	21,561	4,122	1	81	...	1	361	1,253	...	...	...	60,470
1898	1,205	14,743	13,615	18	18,739	3,731	...	72	...	66	444	1,903	...	...	...	55,364
1899	1,321	13,054	13,911	6	21,142	3,848	...	70	...	546	6	2,357	...	...	...	55,304
1900	1,301	13,258	16,196	62	22,363	4,874	...	75	...	336	6	317	...	...	...	63,621
1901	1,207	12,625	14,177	137	21,648	5,757	...	179	10	4,394	5	461	8,787	...	...	63,389
1902	1,120	12,064	13,513	185	21,014	7,481	...	332	37	13,984	6	397	13,984	549	...	88,767
1903	1,163	11,355	12,900	554	20,480	9,186	...	932	139	17,956	9	484	24,382	918	1	109,461
1904	1,113	11,126	12,645	998	18,877	11,339	...	4,251	1,367	22,241	12	501	29,649	2,959	3	117,081
1905	1,118	10,437	11,573	1,217	16,347	10,964	181	12,014	...	28,136	8	376	33,428	8,910	3	134,717
1906	1,243	10,257	10,121	1,214	14,788	7,674	4,397	21,718	...	12,568	7	328	33,099	9,077	3	126,494
1907	1,212	10,905	9,095	821	12,207	5,128	24,282	2,410	43,524	12,323	9	332	39,748	5,000	4	166,095
1908	1,160	9,424	9,523	739	9,823	3,283	33,686	1,801	45,799	11,207	18	380	44,855	5,789	15	178,527
1909	1,135	9,299	10,745	639	10,633	3,296	30,898	1,264	47,859	9,534	20	311	55,472	3,060	6	183,171
1910	1,054	8,795	11,753	489	9,916	2,160	33,143	1,128	52,029	8,899	115	240	73,011	6,841	4	209,557
1911	953	8,248	9,796	473	8,817	1,695	31,317	1,279	56,069	9,526	187	227	81,134	10,721	8	220,449
1912	874	7,383	12,129	484	8,969	970	28,602	1,593	51,427	11,735	1,572	206	87,269	9,263	4	222,935
1913	948	7,917	11,567	595	8,781	956	23,894	2,375	63,579	15,010	2,407	189	97,788	12,499	11	248,446
1914	939	8,170	9,880	503	8,536	1,356	21,920	3,104	73,632	20,068	3,560	223	99,775	14,309	8	265,763
1915	888	7,838	9,265	437	7,825	876	19,042	2,823	97,915	24,943	4,246	208	86,592	18,192	14	281,104
1916	874	7,993	8,731	1,202	7,744	769	17,714	8,738	107,072	27,645	6,234	197	90,952	15,248	8	300,767
1917	880	7,753	8,979	1,028	7,751	760	15,777	36,536	107,508	32,413	8,978	121	93,878	11,392	1	335,316
1918	869	7,405	7,867	4,368	7,368	872	13,368	45,451	103,347	38,750	12,596	121	97,632	16,043	8	355,921
1919	851	8,137	8,327	9,278	7,736	972	11,960	33,048	86,911	79,365	13,172	121	101,183	17,188	15	378,397
1920	906	7,458	8,249	8,738	7,400	945	10,774	39,005	106,206	96,868	16,831	111	103,377	35,714	14	442,929
1921	988	7,418	7,822	9,013	7,385	1,158	10,043	36,456	114,634	106,166	19,333	108	112,600	27,103	12	472,183
1922	1,000	7,425	7,021	8,973	6,781	1,087	9,383	31,768	140,571	118,684	26,715	97	138,468	35,376	9	557,531
1923	1,250	7,609	6,568	5,069	7,085	1,043	8,707	28,950	160,929	131,023	44,785	86	262,876	24,919	8	732,407
1924	1,440	7,486	5,920	6,811	8,935	8,081	7,683	28,536	173,538	134,522	39,498	445	228,933	21,124	10	713,940
1925	1,695	8,097	5,763	6,739	7,212	829	7,863	38,357	176,768	144,048	29,173	1,226	232,492	20,272	24	763,743
1926	1,956	8,961	5,946	6,274	7,272	808	7,760	41,498	179,105	166,916	25,776	2,768	224,673	23,201	43	770,874
1927	2,242	9,526	6,023	6,719	7,593	852	6,994	41,069	277,775	217,389	21,307	2,831	231,196	22,818	60	901,129
1928	2,573	9,876	5,704	7,325	7,630	1,053	6,599	38,352	249,598	256,888	21,415	2,722	231,982	21,626	47	900,364

^a Less than 1,000 barrels.
^b Includes New Mexico, which in 1925 produced 1,060,000 barrels and in 1926, 1,666,000 barrels; also Michigan production in 1925, 4,000 barrels and in 1926, 94,000 barrels.
 Authority: U. S. Bureau of Mines.

COST OF DRILLING OIL WELLS IN 1928

It is estimated that over \$500,000,000 was spent in 1928 in drilling wells for oil and gas. This estimate is based on a canvas of oil producing companies made by the American Petroleum Institute. The companies were asked to supply their estimates of the average cost of drilling in certain districts, as well as to give detailed drilling costs of typical wells in specified fields. The information has been correlated. In every case where averages were given, effort has been made to apply conservative figures. If the total estimated figure is not absolutely correct, it probably errs on the side of underestimation.

The estimated average cost per well in the various districts has been applied to the number of oil and gas wells completed in 1928 in their respective areas. The total number of wells completed in the United States in 1928 was 22,331, at an estimated total gross cost of \$503,332,000, or an average cost per well of \$22,540. All of the wells completed were not producing wells, as many were drilled into unproductive sands and abandoned. Of the 22,331 wells completed, 7,078 were actually reported as dry and 2,727 were gas wells, leaving 12,526 productive oil wells drilled in 1928. Weighting the cost by districts, it cost the industry \$165,799,000 to drill the 7,078 dry holes.

The cost of drilling oil wells is dependent upon many variable factors. Among the determining influences are the distance of the well from available sources of supplies; the depth to be reached; the character of the formations to be penetrated (these in turn determining the system to be employed and the kind and quantity of casing to be used); the number of water-bearing, gas-bearing, caving or other troublesome strata encountered; and the cost of labor, fuel and water.

ESTIMATED GROSS COST OF DRILLING WELLS COMPLETED IN 1928

District	Number of Wells Completed	Estimated Cost of Drilling	Average Cost Per Well
Oklahoma.....	3,679	\$165,555,000	\$45,000
Kansas.....	1,157	28,925,000	25,000
North Central Texas...	3,904	39,040,000	10,000
East Central Texas....	206	3,914,000	19,000
West Texas.....	1,258	44,030,000	35,000
Panhandle of Texas....	396	15,840,000	40,000
Southwest Texas.....	742	14,840,000	20,000
Gulf Coast.....	1,420	39,760,000	28,000
North Louisiana.....	528	12,672,000	24,000
Arkansas.....	364	5,460,000	15,000
New Mexico.....	66	3,960,000	60,000
Wyoming.....	203	7,105,000	35,000
Montana.....	359	5,385,000	15,000
Utah.....	12	600,000	50,000
Colorado.....	140	7,000,000	50,000
California.....	903	81,270,000	90,000
Eastern fields.....	6,994	27,976,000	4,000
Total.....	22,331	\$503,332,000	\$22,540

Authorities: Well completion figures from *Oil & Gas Journal*. Costs estimated by *American Petroleum Institute*.

A 1,000-foot well may cost from \$1,500 to \$15,000, and a 2,500-foot well may cost from \$20,000 to \$150,000, accidents, " fishing " jobs, and consequent delays contributing largely to unusually high costs. The time required for drilling a well to completion may vary from fifteen or twenty days on a 1,500-foot well to a year or more on a 5,000-foot one, although the time necessary to drill wells of from 2,500 to 3,200 feet in depth ordinarily varies from about thirty to perhaps one hundred days.

Drilling to greater depths has been the principal factor to increase the average cost of securing oil production in recent years. Forty years ago, virtually all wells were shallow, few going to depths exceeding 2,000 feet and most not exceeding 1,000 feet. The cost per well was less than \$1,000. Twenty years ago oil was struck at an estimated average depth of 1,500 feet and at an estimated average cost per well of \$2,500. Today wells are being drilled in the principal oil

producing areas to depths of 4,000, 5,000, 6,000, 7,000 feet and more.

As an example of increased drilling costs due in large part to drilling to greater depths, in the early days when the oil region of Oklahoma was confined to Washington, Nowata and Rogers Counties and the eastern part of the Osage Nation, a well was drilled and put on the pump at a cost of a few hundred up to a thousand dollars; and the well records of one of the largest companies show the progressive increase in the average cost as follows:

AVERAGE COST OF DRILLING A WELL IN OKLAHOMA

	Average cost
1912.....	\$3,169
1913.....	4,667
1914.....	6,744
1915.....	8,321
1916.....	6,917
1917.....	7,880
1918.....	11,144
1919.....	21,353
1920.....	26,437
1921.....	35,509
1922.....	23,999
1923.....	23,567
1924.....	23,745
1925.....	27,333
1926.....	31,729
1927.....	32,173
1928.....	45,574

The big jump from \$26,437 in 1920 to an average cost of \$35,509 in 1921 was due to high labor costs. Rig builders were getting \$20 per day; drillers and tool dressers from \$14 to \$16 per day; and everything connected with the drilling of a well or the operation of an oil property had gone to top prices. There was a general settling of prices in the following year. The increases in recent years have been in a large part due to the drilling to deeper sands.

It will be seen from the foregoing figures that in sixteen years the cost of drilling the average Oklahoma oil well has increased about 1,340 per cent. In other words, the price of one average well in Oklahoma in 1928 would have paid for the drilling of fourteen Oklahoma wells in 1912.

The story is much the same for the great producing districts of Texas and California. In both states oil wells have been going down deeper and deeper in search for new productive oil sands. Virtually all the drilling in California has been so-called "deep drilling" since the beginning of the oil industry in that state; but during the last year or two wells have been pushed down to phenomenal depths: Whereas a 4,000-foot well was formerly considered a deep well, the regular order of the day now is for the drill to penetrate to depths of 6,000 and 7,000 feet in certain fields.

Figures showing the average cost of drilling a well scarcely indicate the high costs that go with so-called wildcat drilling operations. There are no figures published attempting to segregate drilling in proven or semi-proven territory from that in wildcat areas; nor is it possible to give an average of what it costs to drill a wildcat well. Obviously, the cost of a wildcat well is much greater than of a well drilled close to other operations in proven territory. In Oklahoma and Kansas alone at the close of 1928 it is estimated that 111 wildcat wells were drilling; 57 were in existence, but were shut down; 9 were started, but were shut down; 45 rigs were building on wildcat locations, and 20 additional locations had been made for wildcat wells to be drilled.

COST OF DRILLING DRY HOLES

It is estimated that the 7,078 dry holes drilled in the search for oil in 1928 cost the industry \$165,799,000. In Oklahoma alone, where there was a total of 1,227 failures, the estimated loss is \$55,215,000. In Texas, exclusive of the Gulf Coast region, there were 2,618 wells which failed to strike oil, costing the producers \$40,544,000. In the Gulf Coast region, 628 wells were dry, representing a total loss of \$17,584,000.

The number of dry holes in California is small, taking into consideration the large oil production represented by that state. There were 191 dry holes; and at an estimated cost of drilling of \$90,000 per well, this is a loss of \$17,190,000.

ESTIMATED AVERAGE GROSS COST OF DRILLING DRY HOLES IN 1928

District	Number of Dry Holes	Estimated Cost Per Well	Estimated Cost of Drilling
Oklahoma	1,227	\$45,000	\$55,215,000
Kansas	455	25,000	11,375,000
North Central Texas . .	1,810	10,000	18,100,000
East Central Texas . . .	101	19,000	1,919,000
West Texas	307	35,000	10,745,000
Panhandle of Texas . . .	89	40,000	3,560,000
Southwest Texas	311	20,000	6,220,000
Gulf Coast	628	28,000	17,584,000
North Louisiana	235	24,000	5,640,000
Arkansas	178	15,000	2,670,000
New Mexico	45	60,000	2,700,000
Wyoming	65	35,000	2,275,000
Montana	120	15,000	1,800,000
Utah	7	50,000	350,000
Colorado	70	50,000	3,500,000
California	191	90,000	17,190,000
Eastern fields	1,239	4,000	4,956,000
Total	7,078	\$23,425	\$165,799,000

Authorities: Well completion figures from *Oil & Gas Journal*. Costs estimated by *American Petroleum Institute*.

WHAT IT COSTS TO DRILL A TYPICAL OIL WELL IN DIFFERENT OIL FIELDS OF THE UNITED STATES

It has been pointed out that to make valid estimates of the cost of the average well is practically impossible, because depths of producing sands vary so from place to place that one should know the cost of all wells in a field or a state to determine the average. The variation in cost also applies to the operations in a single field, where wells are drilling to the same depth but entailing different costs due to differences in availability of supplies, haulage, drilling difficulties, etc.

The greater Seminole area in Oklahoma continued to be the most important producing territory in 1928, and it is estimated that the average cost of drilling an oil well in that area was \$60,000. This is for a completed well only, but with no equipment for pumping or producing the well in any par-

ticular included, nor for any tank batteries or any other leasehold equipment. Individual wells in that territory vary materially from this estimate, depending upon the depth drilled and also upon whether two strings of pipe were used, or—as was the case with many wells—only one string of pipe.

Costs of drilling in Kansas vary considerably. In eastern Kansas the cost ranges from \$2,000 up to perhaps \$20,000. On the other hand, very expensive deep wildcat wells were drilled in that state whose cost exceeded \$100,000. In other sections of the state the cost averages around \$40,000 per well.

The cost of a typical well in the Pyote district of West Texas in 1928 was \$40,000; while in the shallow sand Yates district of Texas the cost of a typical well was about \$12,000.

A rank wildcat in southeast New Mexico cost \$106,000. The great bulk of the drilling in the state was located in this general area. Because of high gas pressures, some of these wells cost more than \$200,000. Few of the wildcats cost less than \$100,000. A moderate number of shallow wells are drilled in the Artesia district at a considerably lower cost.

WHAT IT COST TO DRILL A TYPICAL WELL IN 1928

EARLSBORO POOL—SEMINOLE DISTRICT (OKLAHOMA)

(Depth of well—4350 feet)

Derrick	\$5,000
Casing, shoes, clamps, cement, separator and connections.....	14,500
Tank, line pipe and fittings.....	750
Torpedoes, fuel and water.....	6,500
Teaming and labor.....	2,500
Drilling cost	31,450
Total	<u>\$60,700</u>

MISSION POOL—SEMINOLE DISTRICT (OKLAHOMA)

(Wilcox sand)

Derrick	\$6,014
Casing and cementing.....	14,037
Pipe, tanks, and equipment.....	3,384
Water and fuel.....	2,270
Hauling, construction, and miscellaneous.....	4,150
Drilling cost	31,392
Total	<u>\$61,247</u>

MAUD POOL—SEMINOLE DISTRICT (OKLAHOMA)

(Misener sand—Basal Mississippian)

Derrick	\$7,352
Casing and cementing.....	12,665
Pipe, tanks, and equipment.....	5,178
Water and fuel.....	6,332
Hauling, construction, and miscellaneous.....	5,999
Drilling cost	30,124
Total	\$67,650

CARR CITY—SEMINOLE DISTRICT (OKLAHOMA)

(Depth of well—4817 feet)

Derrick	\$10,040
Labor, teaming, and freight.....	2,257
Casing and pipe.....	12,097
Other equipment	201
Drilling cost	37,722
Total	\$62,317

SOUTH LITTLE RIVER—SEMINOLE DISTRICT (OKLAHOMA)

(Depth of well—4198 feet)

Derrick	\$6,881
Labor, teaming, and freight.....	2,047
Casing and pipe.....	12,693
Other equipment	15
Drilling cost	35,193
Total	\$56,829

SEARIGHT POOL—SEMINOLE DISTRICT (OKLAHOMA)

(Depth of well—4355 feet)

Derrick	\$7,944
Labor, teaming, and freight.....	2,565
Casing	17,689
Other equipment	210
Miscellaneous	619
Drilling cost	41,011
Total	\$70,038

BOWLEGS POOL—SEMINOLE DISTRICT (OKLAHOMA)

(Depth of well—4323 feet)

Derrick	\$7,374
Labor, teaming, and freight.....	3,022
Casing	11,804
Other equipment	284
Miscellaneous	1,134
Drilling cost	48,550
Total	\$72,168

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SEMINOLE POOL (OKLAHOMA)

(Depth of well—4115 feet)

Derrick	\$8,348
Labor, teaming, and freight.....	2,494
Casing	15,926
Other equipment	810
Miscellaneous	1,422
Drilling cost	33,804
Total	<u>\$62,804</u>

NORTH FOX DISTRICT (OKLAHOMA)

Casing and fittings.....	\$6,100
Teaming	926
Fuel and water.....	2,000
Repairs and supplies.....	1,243
Labor and contract drilling costs.....	17,486
Total	<u>\$27,755</u>

VERNON POOL (OKLAHOMA)

(Depth of well—3356 feet)

Derrick	\$2,901
Labor, teaming, and freight.....	1,065
Casing	5,378
Other equipment	65
Miscellaneous	467
Drilling cost	11,198
Total	<u>\$21,074</u>

MARLOW POOL (OKLAHOMA)

(Depth of well—1791 feet)

Derrick	\$1,990
Labor, teaming, and freight.....	404
Casing	292
Other equipment	67
Miscellaneous	271
Drilling cost	9,397
Total	<u>\$12,421</u>

BURBANK POOL (OKLAHOMA)

(Depth of well—2813 feet)

Derrick	\$6,103
Labor, teaming, and freight.....	2,329
Casing	6,416
Other equipment	306
Miscellaneous	457
Drilling cost	11,806
Total	<u>\$27,417</u>

ST. LOUIS POOL (OKLAHOMA)

(Depth of well—4199 feet)

Derrick	\$8,998
Labor, teaming, and freight.....	1,982
Casing and pipe	6,886
Other equipment	94
Drilling cost	37,248
Total	\$55,208

ALLEN DISTRICT (OKLAHOMA)

Derrick	\$5,189
Casing	11,269
Tanks, pipe, pipe fittings.....	965
Other equipment	408
Labor	4,292
Miscellaneous	1,951
Drilling cost	25,644
Total	\$50,718

LOGAN COUNTY (OKLAHOMA)

Derrick	\$10,951
Casing	19,310
Pipe, pipe fittings.....	519
Other equipment	631
Labor	4,600
Miscellaneous	2,437
Drilling cost	72,626
Total	\$111,074

VALLEY CENTER POOL (KANSAS)

(Simpson sand)

Derrick	\$9,376
Casing and cementing.....	21,520
Pipe, tanks, and equipment.....	2,146
Fuel	1,618
Hauling, construction, and miscellaneous.....	1,255
Drilling cost	15,351
Total	\$51,266

WICHITA HEIGHTS—SEDGWICK COUNTY (KANSAS)

(Depth of well—3429 feet)

Derrick	\$6,795
Casing	24,587
Tanks, pipe, fittings, etc.....	2,786
Labor, teaming, and freight.....	2,457
Miscellaneous	242
Drilling cost	16,006
Total	\$52,873

COTTON VALLEY DISTRICT (NORTH LOUISIANA)

Derrick	\$2,936
Casing, cementing; pipe and case fittings, etc.....	20,126
Rig rental	3,360
Drill pipe rental.....	3,172
Teaming	2,475
Fuel and water.....	2,248
Supplies	2,463
Repairs	1,564
Drilling cost	9,159
Total	\$47,503

SMACKOVER DISTRICT (ARKANSAS)

Derrick	\$940
Casing and pipe; cementing, and pipe and case fittings.....	4,480
Rig rental	925
Teaming	995
Fuel	307
Supplies	1,647
Drilling cost	2,706
Total	\$12,000

CROSS CUT DISTRICT (NORTH CENTRAL TEXAS)

Casing and fittings.....	\$2,836
Rig rental	570
Teaming	264
Water and fuel.....	23
Repairs and supplies.....	101
Drilling cost	1,503
Total	\$5,297

JACKSONVILLE DISTRICT (EAST CENTRAL TEXAS)

Derrick	\$3,139
Casing and tubing; cementing; pipe, case and tube fittings, etc.....	16,920
Rig rental	1,080
Drill pipe rental.....	2,285
Teaming	1,778
Repairs and supplies.....	2,962
Drilling cost	6,091
Total	\$34,255

PYOTE DISTRICT (WEST TEXAS)

Derrick	\$4,256
Casing and fittings.....	7,274
Rig rental	2,280
Drill pipe rental.....	1,599
Teaming	3,885
Repairs and supplies.....	11,879
Drilling Cost	8,286
Total	\$39,459

YATES DISTRICT (WEST TEXAS)

Casing and fittings.....	\$3,583
Teaming	945
Supplies and repairs.....	127
Labor and contract drilling costs.....	8,790
Total	<u>\$13,445</u>

WINKLER COUNTY (WEST TEXAS)

(Depth of well—2735 feet)

Derrick	\$8,022
Labor, teaming, and freight.....	2,377
Casing and pipe.....	6,850
Other equipment	1,862
Drilling cost	21,873
Total	<u>\$40,984</u>

GRAY COUNTY DISTRICT (TEXAS PANHANDLE)

(Depth of well—2670 feet)

Derrick	\$4,271
Labor, teaming, and freight.....	3,293
Casing and pipe.....	7,087
Other equipment	136
Drilling cost	15,320
Total	<u>\$30,107</u>

PAMPA DISTRICT (TEXAS PANHANDLE)

Derrick	\$4,995
Casing and fittings.....	9,657
Teaming	1,175
Water	490
Supplies	441
Labor and contract drilling costs.....	20,542
Total	<u>\$37,300</u>

BRUNI DISTRICT (SOUTHWEST TEXAS)

Derrick	\$1,406
Casing; pipe and case fittings, etc.....	5,496
Rig rental	2,100
Drill pipe rental.....	612
Teaming	1,284
Fuel	1,245
Repairs and supplies.....	1,206
Drilling cost	5,722
Total	<u>\$19,071</u>

LULING DISTRICT (SOUTHWEST TEXAS)

Derrick	\$2,010
Casing and fittings.....	2,303
Teaming	470
Fuel and water.....	2,158
Supplies	960
Labor and contract drilling costs.....	7,863
Total	<u>\$15,764</u>

SUGARLAND DISTRICT (GULF COAST)

Casing; pipe and case fittings, etc.....	\$17,570
Rig rental	2,930
Drill pipe rental.....	824
Teaming	1,243
Fuel and water.....	1,121
Repairs and supplies.....	3,002
Drilling cost	5,813
Total	<u>\$35,503</u>

RACCOON BEND DISTRICT (GULF COAST)

Casing; pipe and case fittings, etc.....	\$16,354
Rig rental	2,500
Drill pipe rental.....	793
Teaming	1,925
Fuel and water.....	2,220
Supplies	5,519
Drilling cost	6,894
Total	<u>\$36,205</u>

LEA COUNTY, NEW MEXICO

(Wildcat Well)

Derrick	\$5,330
Casing and cementing.....	26,733
Pipes, tanks, and equipment.....	9,975
Water and fuel.....	4,942
Hauling and construction.....	32,473
Miscellaneous (camp material and commissary).....	5,924
Drilling cost	21,070
Total	<u>\$106,447</u>

WHAT IT COSTS TO DRILL IN CALIFORNIA

During 1928 all companies in California completed 903 oil and gas wells, of which 712 were producing oil wells. The aggregate gross cost of drilling all these wells is estimated at \$81,270,000. The average depth of wells drilled in Cali-

foria is estimated at 4,500 feet, which at \$20 per foot makes the indicated average cost \$90,000 per well.

As elsewhere, the cost of drilling in California is dependent upon the depth of wells and the accessibility of the location in which they are drilled. The cost increases rapidly as depth is reached; and the matter of transportation of material and of men to the well site will largely increase such cost.

Leaving out of the calculations certain drilling machinery constituting the drilling rig, and taking into consideration only those facilities which are left with the well when completed, the following tabulation will give a fair estimate of the cost of drilling a well of from 6,000 to 6,500 feet in depth in the Los Angeles Basin, California. This is given in complete detail.

COST OF DRILLING TYPICAL WELL LOS ANGELES BASIN (CALIFORNIA)

Material	
Steel derrick complete.....	\$5,845
Sand reel and band wheel.....	1,000
Calf wheel	230
Lumber for flooring and housing.....	1,000
1100 ft. 20 in. casing.....	8,558
4300 ft. 13½ in., 61 lb. casing.....	15,134
5900 ft. 9 in., 45 lb. casing.....	11,703
5800 ft. 6 4/8 in., 28 lb. casing.....	7,714
500 ft. 6½ in., 28 lb. perforated casing.....	1,915
6300 ft. 3 in. tubing.....	3,597
6300 ft. ¾ in. sucker rods.....	693
Pump and fittings.....	75
Casing shoes and guide.....	450
Casing heads and fittings.....	3,000
3 in. line pipe.....	334
Miscellaneous pipe and fittings.....	2,500
Material for telephone installation.....	175
Rig irons	750
Belting	300
Oil well cement.....	900
Foundation cement	200
Crushed rock and sand.....	300
Corrugated iron	300
Landing clamps	50
Guy wire, turn buckles, etc.....	75
Electrical material	350
Total material cost.....	\$67,148

Drilling	
Labor—drilling	\$25,000
Labor—miscellaneous	5,500
Labor—installing telephone	75
Drilling tool maintenance (represents repairs and replacement incident to wear and tear on drilling rig)	19,800
Cementing well	1,000
Fuel—gas	4,000
Water and electricity	1,000
Shop work	500
Hauling material	2,500
Coring	5,000
Oil waste—packing, etc.	500
Steel lines	2,500
Miscellaneous material	3,500
Digging sump, laying of water lines, and incidental hauling	1,500
Total drilling cost	\$72,375
Grand total	\$139,523

A study of the above shows a total cost of \$139,523, of which \$67,148 is for material alone. Labor and drilling cost amounted to \$50,375; while fuel, gas, water, electricity, cementing, hauling material, quarrying, etc., added \$20,500. In other words, \$70,875 was spent for labor and supplies, expended solely in the drilling of the well. Besides this sum, there is to be included a cost of digging sump, laying of water lines, and incidental hauling, in round figures of about \$1,500.

Average drilling costs per foot of wells in various California fields are shown as follows:

COST OF DERRICKS ERECTED, COMPLETE

Wood—122 feet for rotary	\$5,000
Steel—122 feet for rotary	7,500

COST OF DRILLING COMPLETED WELL

Depth	Location	Average Cost Per Foot Including Casing
1,000 feet		\$10.00
1,800 feet	Mt. Poso Field	13.50
3,000 feet	Midway Field	17.50
4,600 feet	Yorba Linda	23.50
5,800 feet	Santa Fe Springs	23.50
7,000 feet	Signal Hill	18.00

Cable tools are now obsolete for drilling new wells in California. Rotary tools are used almost exclusively, operating costs averaging about \$500 per day. Details of these costs are as follows:

	Cost per day
Labor	\$120
Supervision	30
Fuel and water.....	40
Rotary equipment depreciation.....	200
Tool repairs, including drilling bits.....	110
Total	\$500

However, this condition does not apply to wildcat wells drilled in inaccessible places, where hauling and trucking charges are exorbitant.

During the year 1928, only one well was completed in the Kettleman Hills Field; and it is estimated that drilling costs—which are exceptionally high for operating in this field, where there is excessive road work and grading involved—will exceed \$250,000 per well.

The approximate cost of drilling typical wells in California fields is shown in the following table (all this drilling with company's own tools):

APPROXIMATE COST—DRILLING—TYPICAL WELLS IN CALIFORNIA FIELDS

	Kern River West Front (Near Bakers- field, Kern County)	Ingle- wood (Los Angeles County)	Buena Vista Hills (Near Taft, Kern County)	North Flank, Buena Vista Hills (Taft)	Rincon Hill (Sea Cliff) near Ventura, Ventura County	Huntington Beach, Orange County		Santa Fe Springs, Los Angeles County, Buckbee Zone	Kettle- man Hills (West end of Kings County)
						On Ocean Front	Bolsa Zone		
Approximate Average Depth.....	2,200	2,300	3,000	4,600	3,500	4,300	3,800	5,800	7,200
Approximate Average Cost									
Rig.....	\$ 3,400	\$ 7,380	\$ 7,500	\$ 8,200	\$ 9,000	\$ 7,840	\$ 7,854	\$ 6,350	\$ 7,150
Casing, Tubing and Rods, Producing Equipment.....	14,150	17,760	22,729	22,032	32,100	33,924	30,948	45,000	64,275
Drilling Crew Labor....	4,000	4,500	5,200	4,360	9,300	9,600	6,660	16,000	21,738
Upkeep Drilling Equipment.....	4,000	4,800	5,720	4,500	10,200	11,000	7,325	17,600	29,346
Other Expenses.....	9,240	13,171	12,945	18,237	16,160	23,773	23,138	35,974	75,228
Total.....	\$34,790	\$47,611	\$54,094	\$57,329	\$76,760	\$86,137	\$75,925	\$120,924	\$197,737
Cost per Foot.....	15.81	20.70	18.03	12.46	21.93	20.03	19.98	20.85	27.46

TRANSPORTATION AND STORAGE OF OIL IN THE UNITED STATES

PETROLEUM PIPE LINES

At the present time there is probably in the United States a petroleum pipe line system of over 100,000 miles. The Interstate Commerce Commission reports for interstate pipe lines alone a mileage of 76,070 miles at the end of 1927, representing an investment of \$609,439,000.

INTERSTATE PIPE LINES

	Miles of Line Operated	Investment in Pipe Lines
1921.....	55,260	\$365,024,499
1922.....	57,349	382,279,598
1923.....	64,760	432,065,360
1924.....	68,185	496,187,164
1925.....	70,008	511,087,922
1926.....	72,840	539,409,607
1927.....	76,070	609,438,885

Authority: Compiled from reports made to Interstate Commerce Commission.

A survey of the petroleum pipe lines by the U. S. Bureau of Mines, as of May 1, 1926, shows that on that date there was a total of slightly more than 90,000 miles of pipe lines in the United States, having a capacity of approximately 15,750,000 barrels. These lines varied in diameter from 2 to 16 inches, the weighted average being 6 inches.

The total pipe line mileage, according to the U. S. Bureau of Mines' survey, was about equally divided between trunk lines and gathering lines, though the capacity of the former was about four times that of the latter.

STORAGE OF CRUDE OIL AND PRODUCTS

The grand total of tankage (according to a survey made by the U. S. Bureau of Mines), exclusive of producers' stor-

age at the wells, available in the United States for the storage of crude petroleum and of petroleum products at refineries, on May 1, 1926, amounted to over 800,000,000 barrels of 42 U. S. gallons. This total is given as 815,994,000 barrels in the table which follows; but, owing to the fact that some types of crude storage equipment are moved from place to place as old fields decline and new fields come in, and also owing to new construction and abandonment of old construction, it is advisable to consider the total in round numbers only.

In addition to the tank capacity, the pipe lines of the country have a capacity of 16,000,000 barrels. For it is a feature of pipe line transportation that the lines to be operating must always be full of oil; in other words, there are always about 16,000,000 barrels of oil in permanent pipe line storage.

On May 1, 1926, there were 530,000,000 barrels (net) of oil (410,000,000 barrels of crude petroleum and 120,000,000 barrels of refined oils) held in tank farms, in pipe lines, and at refineries. There were also approximately 20,000,000 barrels of liquid in storage, indicating the utilization of 66 per cent of total capacity. Of the total tank capacity, nearly 500,000,000 barrels were at tank farms and over 300,000,000 barrels at refineries. Of the latter, 80,000,000 barrels was crude oil storage.

Tank farm storage comprised by far the major portion of the total capacity for crude petroleum of the country, and also the major portion of the total capacity of all oils. This type of storage includes tanks on farms and along pipe lines, but does not include crude storage at refineries or on producing properties. Owing to incomplete information, storage on producing properties, which is estimated as 10,000,000 barrels, is not considered in this survey.

There are four types of storage, viz., steel, wooden, earthen, and concrete. Steel storage is by far the most widely used and comprises 80 per cent of the total. The remainder is about evenly divided between earthen and concrete storage, with wooden storage almost negligible.

PETROLEUM FREIGHT CARRIED BY RAILROADS

Petroleum ranks first among rail shipments of manufactured products, both crude oil and refined products being shipped by rail, although the bulk of crude oil is moved by pipe line. How materially petroleum has contributed to the growth of business of railroads is shown by the fact that the oil movement in 1928 represented a gain of 79 per cent over that of 1920.

OIL TRANSPORTED BY RAILROADS

Year	Crude Oil Tons	Refined Products Tons
1920.....	6,401,572	29,621,187
1921.....	6,044,513	27,621,187
1922.....	5,935,997	30,863,324
1923.....	8,335,653	36,401,305
1924.....	8,411,660	41,297,561
1925.....	11,245,000	46,273,000
1926.....	10,740,000	48,938,000
1927.....	10,548,000	51,663,000
1928.....	7,632,000	56,777,000

Authority: Interstate Commerce Commission.

TANK CARS IN PETROLEUM SERVICE

The rail movement of crude oil and petroleum products is handled by tank cars. Most of the cars in petroleum service

TANK CARS IN PETROLEUM SERVICE

January 1	Privately Owned	Railroad Owned	Total
1914.....	30,764	10,462*	41,226
1915.....	31,541	10,514*	42,055
1916.....	35,348	11,723*	47,071
1917.....	43,734	13,287*	57,021
1918.....	60,014	12,217*	72,231
1919.....	70,601	13,094*	83,695
1920.....	82,898	13,282*	96,180
1921.....	105,071	13,766*	118,837
1922.....	114,829	14,136*	128,965
1923.....	118,926	14,600*	133,526
1924.....	126,031	13,110	139,141
1925.....	125,862	13,451	139,313
1926.....	128,797	12,685	141,482
1927.....	130,913	13,985	144,898
1928.....	141,346	15,950	157,296

Authority: Compiled from Railway Equipment Register.

* Includes cars in services other than petroleum.

are owned by the petroleum industry, the railroads thus being saved the capital requirements represented by ownership and maintenance of this equipment. In 1914, as few as 41,000 tank cars took care of the rail shipment of petroleum. In 1928, there were 157,296 cars in petroleum service.

TRANSPORTATION BY TANK VESSELS

The tank vessel has become an increasingly important transportation agency, both for the carrying of crude oil and refined products, in domestic trade and in foreign trade. The principal movements of American tank vessels (for tanker statistics see *World Transportation of Petroleum*) are in the carrying of crude oil from Mexico and northern South American countries to refinery points in the United States; in the carrying of Mid Continent crude oil and refined products from Mid Continent and Gulf Coast refineries to the Atlantic seaboard refineries and markets, and to foreign markets; in the carrying of crude oil and refined products from California through the Panama Canal to eastern points and abroad; while there is an unceasing movement of tankers carrying refined products from coastal refinery points in the United States to the markets of the world.

SHIPMENTS OF CALIFORNIA OIL THROUGH PANAMA CANAL
(Thousands of Barrels)

	1924	1925	1926	1927	1928
Crude Oil.....	39,300	14,545	11,104	10,692	2,300
Refined Products:					
Gasoline.....	2,696	10,280	8,453	11,675	16,779
Tops.....	1,114	1,577	244	....	263
Gas Oil.....	....	828	5,800	4,197	2,504
Fuel Oil.....	946	821	8,115	7,010	848
Lubricants.....	559	526	557	355	335
Asphalt.....	....	....	14	17	28
Kerosene.....	....	....	....	24	....
Total Refined.....	5,315	14,032	23,163	23,328	20,757
Total.....	44,615	28,577	34,267	34,020	23,057

Authority: U. S. Bureau of Mines.

NOTE.—Figures are approximate.

The enormous petroleum traffic through the Panama Canal in recent years has had no small part in the Canal's financial success. (See "Petroleum Facts and Figures," first edition.)

Tank vessels paid \$5,436,437 in canal tolls for the fiscal year 1928, accounting for 20.1 per cent of the total tolls. On account of increased output from oil fields which have their access to the sea on the Atlantic coast of the Americas, tanker traffic through the canal declined considerably during the year. It shows a decrease of about 15 per cent when compared with that of 1927. Tanker transits total 1,121 as compared with 1,324 during 1927, a decrease of 203. Tank ships comprised 17.3 per cent of the total commercial transits during the year; made up 21.2 per cent of the Panama Canal net tonnage; paid 20.1 per cent of the total tolls collected, and carried 19.7 per cent of the cargo which passed through the canal.

Omitting transits of public vessels of the United States and other vessels exempt from the payment of tolls, the number of ocean-going vessels transiting the canal daily averaged 17.6 throughout the year. Of this number, tank ships averaged three transits daily, the balance of 14.6 being made up of general cargo carriers, passenger ships, warships of foreign nations, etc.

In the tables below, the commercial traffic has been segregated to show the proportion of tanker transits, tonnage, and tolls, as compared with corresponding figures embracing all other classes of traffic. The figures are for the fiscal years 1923 to 1928, inclusive, covering the era of the growth and decline of tanker traffic:

PROPORTION OF TANK SHIPS TO TOTAL TRAFFIC

Year	Total commercial transits			Average daily transits		
	Tankers	General	Total	Tankers	General	Total
1923.....	913	3,054	3,967	2.5	8.3	10.8
1924.....	1,704	3,526	5,230	4.6	9.6	14.2
1925.....	1,079	3,594	4,673	2.9	9.8	12.8
1926.....	1,090	4,107	5,197	3.0	11.2	14.2
1927.....	1,324	4,151	5,475	3.6	11.4	15.0
1928.....	1,121	5,335	6,456	3.0	14.6	17.6

PROPORTION OF TANKER TONNAGE TO TOTAL TONNAGE

Fiscal year	Panama Canal net tonnage•			Percentage of total net tonnage		
	Tankers	General	Total	Tankers	General	Total
1923.....	5,374,384	13,231,402	18,605,786	28.9	71.1	100
1924.....	10,212,047	15,936,831	26,148,878	39.1	60.9	100
1925.....	6,424,622	16,430,529	22,855,151	28.1	71.9	100
1926.....	6,324,240	18,431,351	24,774,591	25.5	74.5	100
1927.....	7,624,112	18,603,703	26,227,815	29.1	70.9	100
1928.....	6,243,969	23,214,665	29,458,634	21.2	78.8	100

PROPORTION OF TOLLS FROM TANK SHIPS TO TOTAL TOLLS FROM ALL VESSELS

Fiscal year	Tolls paid by shipping using canal			Percentage of total tolls		
	Tankers	General	Total	Tankers	General	Total
1923.....	\$4,769,324.63	\$12,738,874.94	\$17,508,199.57	27.2	72.8	100
1924.....	9,071,835.65	15,219,127.89	24,290,963.54	37.3	62.7	100
1925.....	5,728,302.26	15,672,221.25	21,400,523.51	26.8	73.2	100
1926.....	5,626,167.93	17,304,888.05	22,931,055.98	24.4	75.6	100
1927.....	6,658,806.90	17,570,023.21	24,228,830.11	27.5	72.5	100
1928.....	5,436,437.16	21,508,062.61	26,944,499.77	20.1	79.9	100

Authority: The Panama Canal

REFINERIES AND REFINING IN THE UNITED STATES

GROWTH OF PETROLEUM REFINING

The modern petroleum industry began in 1859, when Drake drilled the first oil well in Pennsylvania. People commonly say Drake "discovered" petroleum, but in fact he merely discovered how to get it cheaply and in quantities, by boring. Before Drake's time, kerosene had been refined; kerosene lamps had been invented, and fortunes had been made from it. But the kerosene of those days was distilled from coal or shales, or from the skimmings of oil springs. There were a half-dozen refineries in Pittsburgh, and a half-hundred in the country, before the Drake well was drilled. Pittsburgh seriously considered lighting its streets with kerosene thirty years before the Drake well was drilled. Drake merely brought enlargement of the supply, and set men finding means to utilize it.

At first they distilled kerosene from petroleum, for illumination. This process left a considerable share of gasoline, explosive and dangerous. For many years gasoline was a great nuisance; but finally came the internal combustion engine, in which a little gasoline vapor, mixed with fourteen or fifteen times as much air, would produce an explosion: that, at the head of a piston, would run an engine most cheaply. Presently somebody hitched one of these engines to a vehicle—the beginning of the automobile. Since then pretty nearly everybody has been hitching gasoline engines to vehicles.

In 1859, the Census Bureau reported 78 refineries. These were small plants, scarcely indicative of the vast industrial establishment represented by the modern refinery. In 1927, there were 354 refineries, employing 71,000 wage earners, and paying over one hundred million dollars in wages.

PETROLEUM REFINING INDUSTRY IN THE UNITED STATES

	Number of Establishments	Wage Earners	Wages	Cost of Materials	Value of Products
1859.....	78	1,473	\$556,000	\$3,062,000	\$6,398,000
1869.....	170	1,870	1,185,000	21,450,000	26,942,000
1879.....	86	9,869	4,382,000	34,999,000	43,705,000
1889.....	94	11,403	5,872,000	67,919,000	85,001,000
1899.....	67	12,199	6,717,000	102,859,000	123,929,000
1904.....	98	16,770	9,989,000	139,387,000	175,005,000
1909.....	147	13,929	9,830,000	199,273,000	236,998,000
1914.....	176	25,366	19,397,000	325,265,000	396,361,000
1919.....	320	58,889	89,750,000	1,247,908,000	1,632,533,000
1921.....	366	63,189	102,294,000	1,382,170,000	1,727,440,000
1923.....	382	66,717	103,834,000	1,425,053,000	1,793,700,000
1925.....	359	65,324	104,645,000	1,889,678,000	2,376,657,000
1927.....	354	71,234	113,717,000	1,752,997,000	2,133,923,000

From U. S. Census Reports.

REFINERIES IN UNITED STATES

	Building		Completed	
	Number	Daily Capacity Barrels	Number	Daily Capacity Barrels
January 1, 1914*.....	..	.....	176	.....
January 1, 1918.....	..	.....	267	1,186,155
January 1, 1919.....	..	.....	289	1,295,115
January 1, 1920.....	99	263,500	373	1,530,565
January 1, 1921.....	44	76,600	415	1,888,800
January 1, 1922.....	30	59,950	479	2,109,200
November 1, 1924.....	8	18,200	547	2,814,332
January 1, 1925.....	6	37,000	541	2,827,837
May 1, 1925.....	4	11,000	550	2,853,842
January 1, 1926.....	2	5,500	510	2,852,967
January 1, 1927.....	7	61,000	466	3,061,007
January 1, 1928.....	5	22,000	423	3,250,380
January 1, 1929.....	14	99,000	413	3,509,540

Authority: U. S. Bureau of Mines.

* From the U. S. Bureau of the Census.

As of January 1, 1929, the U. S. Bureau of Mines reported 413 refineries in the United States, with a total crude oil capacity of 3,509,540 barrels. Refinery capacity has more than doubled since 1920 when 373 refineries were reported, having a total average capacity of 1,530,565 barrels.

RECAPITULATION BY STATES (January 1, 1929)

State	Number				Capacity (barrels per day)			
	Op.	S. D.	Bldg.	Total	Operating	Shut down	Building	Total
Arizona.....	2	1	..	3	900	500	....	1,400
Arkansas.....	8	1	1	10	35,000	440	2,000	37,440
California.....	52	16	1	69	841,460	45,000	30,000	916,460
Colorado.....	3	..	..	3	3,350	....	....	3,350
Georgia.....	1	..	..	1	5,000	....	....	5,000
Illinois.....	8	2	..	10	106,300	2,000	....	108,300
Indiana.....	4	..	..	4	147,500	....	....	147,500
Kansas.....	15	4	..	19	126,500	11,000	....	137,500
Kentucky.....	7	1	..	8	18,200	4,500	....	22,700
Louisiana.....	14	3	..	17	216,830	9,500	....	226,330
Maryland.....	2	3	..	5	40,000	15,000	....	55,000
Massachusetts...	3	..	..	3	70,000	....	....	70,000
Michigan.....	1	..	1	2	1,500	....	6,000	7,500
Missouri.....	2	1	..	3	14,500	2,000	....	16,500
Montana.....	13	6	..	19	17,500	5,200	....	22,700
New Jersey.....	7	..	..	7	291,000	....	....	291,000
New Mexico.....	4	2	..	6	3,450	2,100	....	5,550
New York.....	4	..	..	4	34,500	....	....	34,500
Ohio.....	12	..	..	12	68,050	....	....	68,050
Oklahoma.....	42	11	1	54	274,700	27,800	1,000	303,500
Pennsylvania....	47	5	..	52	203,650	4,180	....	207,830
Rhode Island....	2	..	..	2	11,200	....	....	11,200
South Carolina..	1	..	..	1	15,000	....	....	15,000
Tennessee.....	1	..	..	1	500	....	....	500
Texas.....	68	13	9	90	658,100	52,480	57,000	767,580
Utah.....	1	1	..	2	4,500	200	....	4,700
Virginia.....	1	..	..	1	1,500	....	....	1,500
Washington.....	..	1	..	1	....	1,000	....	1,000
West Virginia...	5	..	..	5	14,500	....	....	14,500
Wyoming.....	11	1	1	13	100,700	750	3,000	104,450
Total.....	341	72	14	427	3,325,890	183,650	99,000	3,608,540

Authority: U. S. Bureau of Mines.

PRODUCTS FROM A BARREL OF CRUDE OIL

Petroleum is a mixture of many hydrocarbons, which boil and vaporize at different temperatures. When a quantity is introduced into a still and subjected to gradually increasing heat, the lightest elements rise and escape as vapor, precisely as steam escapes from the spout of a tea kettle. These vapors are then condensed. The lightest to come off are the

naphthas and gasoline; then, at a somewhat higher temperature, kerosene vaporizes, flows away, and is in turn condensed. Next come the still heavier oils, which ultimately become lubricants, paraffine and various other products. In the refining of asphaltic crude, the asphalt will not distill over and is left as residue in the still and is then recovered for commercial use. Such is a simple statement of the bare elements in the process commonly known as "straight" refining.

In response to changing demands for different petroleum products, refining operations have had to be adjusted so that the products in greatest demand could be supplied in sufficient quantity. The most striking and revolutionary adjustment came with the tremendously increasing requirements for gasoline, previously a waste product.

To produce more gasoline, more crude oil had to be run through the refinery stills, and the running of more crude oil produced not only more gasoline but more of the other products which result from the process of refining, with consequent problems of disposing of such products.

But by improvements of old methods and processes and the inauguration of new ones, the industry has been able greatly to increase the yield of gasoline from the crude oil instead of that of kerosene and lubricating oil. The yield of gas oil and fuel oil, however, is the largest of any product, and a market has had to be found for it, largely in competition with coal.

In 1899, only 5.4 gallons of gasoline were derived from a 42-gallon barrel of crude oil run through American refineries. On the other hand, 24.2 gallons of kerosene were produced (kerosene being the product then in principal demand), together with 5.9 gallons of gas and fuel oil, and 3.8 gallons of lubricating oil.

Today 15.8 gallons of gasoline are derived; only 2.8 gallons of kerosene; 19.6 gallons of gas and fuel oil; and 1.6 gallons of lubricating oil. How the petroleum industry has squeezed more gasoline out of a barrel of crude oil is indicated in the following table:

PRINCIPAL PRODUCTS YIELDED FROM 42-GALLON BARREL OF CRUDE OIL

Year	Gasoline Gallons	Kerosene Gallons	Gas and Fuel Oil Gallons	Lubricating Oil Gallons
1899.....	5.4	24.2	5.9	3.2
1909.....	4.5	13.9	14.1	4.5
1919.....	10.8	6.5	20.44	2.4
1926.....	14.7	3.3	19.7	1.7
1927.....	15.1	2.9	19.9	1.6
1928.....	15.8	2.8	19.6	1.6

PRINCIPAL PETROLEUM PRODUCTS YIELDED FROM 42-GALLON BARREL
OF CRUDE OIL AVERAGES FOR THE UNITED STATES

Year	Gasoline and Naphtha		Kerosene		Gas and Fuel Oil		Lubricants	
	Per Cent	Gallons	Per Cent	Gallons	Per Cent	Gallons	Per Cent	Gallons
1880.....	10.3	4.3	75.2	31.6	...	...	2.1	0.9
1889.....	12.8	5.4	65.9	27.7	...	...	7.7	3.2
1899.....	12.9	5.4	57.6	24.2	14.0	5.9	9.1	3.8
1904.....	10.3	4.3	48.3	20.3	12.8	5.4	11.6	4.9
1909.....	10.7	4.5	33.0	13.9	33.6	14.1	10.7	4.5
1914.....	18.2	7.6	24.1	10.1	46.5	19.5	6.6	2.8
1917.....	21.5	9.0	13.1	5.5	49.2	20.7	5.7	2.4
1918.....	25.3	10.6	13.3	5.6	53.5	22.5	6.2	2.6
1919.....	25.2	10.8	15.4	6.5	50.2	21.1	5.6	2.4
1920.....	26.1	11.0	12.7	5.3	48.6	20.4	5.7	2.4
1921.....	27.1	11.4	10.5	4.4	51.9	21.8	4.7	2.0
1922.....	28.8	12.1	11.0	4.6	50.9	21.4	4.7	2.0
1923.....	30.0	12.6	9.6	4.0	49.5	20.4	4.5	1.9
1924.....	31.2	13.1	9.3	4.0	49.8	20.9	4.3	1.8
1925.....	32.4	13.6	8.1	3.4	49.3	20.7	4.2	1.8
1926.....	34.9	14.7	7.9	3.3	46.9	19.7	4.1	1.7
1927.....	36.0	15.1	6.8	2.9	47.4	19.9	3.8	1.6
1928.....	37.5	15.8	6.6	2.8	46.7	19.6	3.8	1.6

Authorities: Basic data taken from Bureau of Census Reports for years 1880 to 1914, inclusive, and from Bureau of Mines Reports for 1917 to 1924, inclusive.

When kerosene was the principal product of petroleum, it represented over 50 per cent of the yield from crude oil. The advent of the automobile around 1909, creating a demand for gasoline, resulted in a considerably lower percentage yield for kerosene, so that the lighter fractions of crude oil could be used for making gasoline.

At the present time, the kerosene yield amounts to less than 7 per cent. The gasoline yield has increased from around 10 per cent to over 37 per cent.

GASOLINE PRODUCTION BY DIFFERENT METHODS

(Thousands of Barrels)

Refining districts	Straight refining		Cracking		Natural gas gasoline run through refineries		Total	
	Barrels	%	Barrels	%	Barrels	%	Barrels	%
East Coast.....	29,700	55.3	21,790	40.6	2,204	4.1	53,694	100.0
Appalachian.....	10,583	66.6	4,579	28.8	732	4.6	15,894	100.0
Ind.-Ill.....	30,211	54.2	23,279	41.8	2,226	4.0	55,716	100.0
Okl.-Kansas.....	36,553	60.0	19,758	32.4	4,632	7.6	60,943	100.0
Texas.....	43,051	53.2	30,849	38.2	6,963	8.6	80,863	100.0
Louisiana-Ark.....	13,439	50.4	8,141	30.5	5,082	19.1	26,662	100.0
Rocky Mountain.....	8,333	50.5	6,780	41.1	1,384	8.4	16,497	100.0
California.....	47,567	71.1	7,205	10.8	12,142	18.1	66,914	100.0
Total, 1928.....	219,437	58.2	122,381	32.4	35,365	9.4	377,183	100.0
Total, 1927.....	197,047	59.6	101,226	30.7	32,162	9.7	330,435	100.0
Texas, La., Gulf Coast.....	39,581	47.9	33,587	40.6	9,557	11.5	82,725	100.0

The largest quantity of gasoline produced by any refining district was that of the Texas division, amounting to 80,863,000 barrels in 1928. Of the total production, 53.2 per cent was straight-run gasoline, 38.2 per cent cracked gasoline, and 8.6 per cent natural gas gasoline run through the refineries.

Oklahoma-Kansas produced 60,943,000 barrels of gasoline, 60 per cent of which was straight-run gasoline, 32.4 per cent cracked gasoline, and 7.6 per cent natural gas gasoline.

California produced 66,914,000 barrels of gasoline, of which 71.1 per cent was straight-run gasoline, 10.8 per cent cracked gasoline, and 18.1 per cent natural gas gasoline.

The Indiana-Illinois, East Coast, and Rocky Mountain districts show the highest percentage of cracked gasoline recovery, all reporting over 40 per cent.

GASOLINE FROM CRUDE OIL

Less crude oil is being produced in the United States per automobile registered than in 1918, although petroleum production has increased from 355,928,000 barrels annually in 1918 to 900,364,000 barrels in 1928.

At the end of 1918, there were 6,147,000 motor vehicles registered, and the production of oil amounted to 57.9 barrels per car. At the end of 1928, there were 24,493,000 motor vehicles registered, and the oil production in 1928 amounted to 36.8 barrels per car.

Superficially, it would seem that crude oil production has not been able to keep pace with automotive demand, despite the enormous increase in output shown. But this is not the case, for scientific discoveries and improvements in refining now make the crude oil go farther by greatly increasing the yield of gasoline. The "cracking" process is largely responsible.

CRUDE OIL AVAILABLE PER AUTOMOBILE IN THE UNITED STATES

Year	Crude oil produced Barrels	Motor vehicles registered end of year	Oil available per car Barrels
1918.....	355,928,000	6,147,000	57.9
1919.....	378,367,000	7,565,000	50.0
1920.....	442,929,000	9,232,000	48.0
1921.....	472,183,000	10,463,000	45.1
1922.....	557,531,000	12,238,000	45.6
1923.....	732,407,000	15,092,000	48.5
1924.....	713,940,000	17,594,000	40.6
1925.....	763,743,000	19,954,000	38.3
1926.....	770,874,000	22,001,000	35.0
1927.....	901,129,000	23,133,000	39.0
1928.....	*900,364,000	24,493,000	36.8

* Preliminary

INCREASED RECOVERY OF GASOLINE

The molecules comprising the lighter components of petroleum are very small; hence the extreme volatility of gasoline and of kerosene, which is but slightly less. The molecules of the heavier parts of oil are larger; the volatility less. Thus after the more volatile gasoline and kerosene are taken off the crude oil, the gas oil and fuel oil which are left are far less volatile.

It was discovered that when these heavier parts are subjected to intense heat, the molecules break and become as

volatile as were the lighter parts. So, if the heavier elements are run into a still built for the purpose and are raised to a high enough temperature (provided the vapors are prevented from escaping), the molecules will "crack," and heavy oils will be converted into gasoline. This process is known as "cracking."

Since "cracking" was first applied some fifteen years ago, it has been widely adopted and has become one of the guaranties of adequate future supplies of motor fuel. As recently as 1914, less than one-fifth of the barrel of crude oil was made into gasoline. With "cracking," the proportion has risen steadily, until in 1928 over 37 per cent of all crude oil became gasoline.

In 1914, the percentage yield of gasoline was 18.2. By 1917 it had increased to 21.7 per cent. The average gasoline yield on straight refining is about 25 per cent, and the result of cracking operations is clearly shown since 1918 by the steady increase above that figure year after year.

The trend of gasoline yield from a barrel of crude oil since the advent of "cracking" is shown in the following table:

PERCENTAGE YIELD OF GASOLINE

Year	Per cent	Year	Per cent
1914.....	18.2	1922.....	28.8
1917.....	21.5	1923.....	30.0
1918.....	25.3	1924.....	31.2
1919.....	25.2	1925.....	32.4
1920.....	26.1	1926.....	34.9
1921.....	27.1	1927.....	36.0
		1928.....	37.5

GASOLINE FROM CRACKING OPERATIONS

"CRACKED" GASOLINE PRODUCTION

It is estimated that in 1918 8,500,000 barrels of "cracked" gasoline were produced by refineries in the United States. In 1928, there were 122,381,000 barrels produced, equal to the entire production of gasoline in 1921.

ESTIMATED PRODUCTION OF GASOLINE FROM CRACKING

Year	Barrels	Year	Barrels
1918.....	8,500,000	1923.....	35,000,000
1919.....	10,000,000	1924.....	40,000,000
1920.....	15,000,000	1925*.....	68,582,000
1921.....	20,000,000	1926*.....	93,736,000
1922.....	30,000,000	1927*.....	101,226,000
		1928*.....	122,381,000

* Bureau of Mines figures.

“ CRACKED ” GASOLINE SUPPLIES 32 PER CENT OF TOTAL
OUTPUT

In 1928, “ cracked ” gasoline supplied 32 per cent of the total quantity of gasoline manufactured by refineries in the United States. Five years ago the proportion of “ cracked ” gasoline to the total supply was only 19 per cent, and ten years ago it was only 10 per cent.

The following table shows the per cent of total gasoline production represented by the various methods of manufacture in U. S. refineries:

Year	Straight run gasoline Per cent	“Cracked” gasoline Per cent	Natural gasoline run Per cent
1918.....	89	10	1
1924.....	74	19	7
1925.....	66	26	8
1926.....	60	31	9
1927.....	60	30	10
1928.....	58	32	10

SURVEY OF CRACKING PLANTS

According to reports received by the Bureau of Mines, Department of Commerce, as of January 1, 1929, there were 2,205 cracking units completed or building in the United States, with a total daily charging capacity of 1,476,874 barrels. A similar survey of a year ago showed 2,334 units of 1,288,000 barrels total capacity. This indicates that despite a decrease in number of units, there was a material increase in capacity.

CRACKING PLANTS AT UNITED STATES REFINERIES

District	Total units	Capacity, barrels per day			Total
		Operating	Shut down	Building	
East Coast.....	273	192,300	46,100	37,500	275,900
Appalachian.....	77	40,500	3,417	5,700	49,617
Ind., Ill., Ky., etc.....	467	214,033	33,442	13,800	261,275
Okla., Kans., etc.....	426	179,343	22,000	5,900	207,243
Texas.....	416	277,250	19,464	32,750	329,464
La. and Ark.....	77	84,600	750	23,000	108,350
Rocky Mountain.....	394	63,775	22,650	1,600	88,025
California.....	75	142,700	3,000	11,300	157,000
U. S. total.....	2,205	1,194,501	150,823	131,550	1,476,874
Texas Gulf Coast.....	354	248,500	16,014	6,000	270,514
La. Gulf Coast.....	34	57,000	.....	21,000	78,000

WHAT "CRACKED" GASOLINE HAS MEANT TO MOTORISTS

Without the supply of gasoline obtained from "cracking" operations, the use of automobiles could probably not have expanded to its present proportions because of lack of fuel.

The average yearly consumption of gasoline per motor vehicle over the last ten-year period is estimated as 475 gallons. On this basis, "cracked" gasoline supplied the fuel for 10,800,000 motor vehicles in 1928; that is, for as many cars as the total number in operation in this country in 1921. The following table shows the estimated annual production of "cracked" gasoline and what it represents in the number of motor vehicles supplied with fuel:

Year	"Cracked" gasoline production Barrels	Number of motor vehicles supplied
1923.....	35,000,000	3,100,000
1924.....	40,000,000	3,500,000
1925.....	68,582,000	6,100,000
1926.....	93,736,000	8,300,000
1927.....	101,226,000	9,000,000
1928.....	122,381,000	10,800,000

YIELD OF GASOLINE BY DIFFERENT METHODS
(Thousands of Barrels)

Year	Output of refineries Barrels	Estimated amount from cracking Barrels	Natural gas gasoline run through refineries Barrels	Straight run gasoline Barrels	Per cent from crude run
1914.....	34,763	*	*	*	*
1916.....	49,021	*	*	*	*
1917.....	67,870	*	*	*	*
1918.....	85,007	8,500	2,451	74,056	22.7
1919.....	94,235	10,000	2,957	81,288	22.5
1920.....	116,251	15,000	3,153	98,098	22.6
1921.....	122,704	20,000	2,517	100,187	22.6
1922.....	147,672	30,000	3,662	114,010	22.7
1923.....	179,903	35,000	5,487	139,416	24.0
1924.....	213,325	40,000	12,671	160,654	24.9
1925.....	259,601	68,582	19,636	171,383	23.2
1926.....	299,734	93,736	24,399	181,599	23.2
1927.....	330,435	101,226	32,162	197,047	23.8
1928.....	377,183	122,381	35,363	219,439	24.0

* Not available.

Authorities: Figures in columns 1 and 3 are from U. S. Bureau of Mines Reports, except for the year 1914, which are from the Census Report of Manufactures. Figures in column 2 are estimates, except 1925 and 1926, which are from the U. S. Bureau of Mines.

CRUDE OIL RUN THROUGH UNITED STATES REFINERIES
(Thousands of Barrels)

Year	Domestic	Foreign	Total
1918.....	326,025	*	326,025
1919.....	361,520	*	361,520
1920.....	433,915	*	433,915
1921.....	443,363	*	443,363
1922.....	434,976	65,730	500,706
1923.....	538,252	42,986	581,238
1924.....	597,954	45,765	643,719
1925.....	698,582	41,338	739,920
1926.....	737,598	44,963	782,561
1927.....	778,729	50,106	828,835
1928.....	835,157	77,674	912,831

* Runs not separated as to foreign or domestic crude prior to 1922.

Authority: U. S. Bureau of Mines.

CRUDE OIL RUN BY REFINERIES BY DISTRICTS
(Thousands of Barrels)

Districts	1920	1921	1922	1923	1924	1925	1926	1927	1928
East Coast.....	93,636	96,846	100,525	116,759	135,202	128,491	130,643	150,559	170,506
Appalachian.....	21,426	19,289	20,661	21,352	21,958	25,118	28,502	28,941	33,643
Indiana-Illinois.....	41,528	38,338	45,606	51,276	56,399	67,159	69,707	75,807	98,905
Oklahoma-Kansas.....	69,945	63,387	70,934	70,289	79,701	97,612	96,506	101,871	111,342
Texas.....	89,591	91,928	100,696	103,374	125,025	144,282	156,110	167,095	186,076
Louisiana-Arkansas.....	24,892	31,419	34,865	40,806	49,417	66,997	71,012	70,444	75,540
Rocky Mountain.....	16,151	16,406	24,391	27,176	26,737	26,164	29,205	25,026	26,061
California.....	76,746	85,750	103,028	150,206	149,280	184,097	197,579	209,092	210,758
United States.....	433,915	443,363	500,706	581,238	643,719	739,920	779,264	828,835	912,831

Authority: U. S. Bureau of Mines.

GASOLINE YIELD OF U. S. REFINERIES, BY REFINERY DISTRICTS

Districts	1920 Per cent	1921 Per cent	1922 Per cent	1923 Per cent	1924 Per cent	1925 Per cent	1926 Per cent	1927 Per cent	1928 Per cent
East Coast.....	24.7	25.1	27.5	28.4	27.3	29.8	32.4	31.1	30.2
Appalachian.....	32.0	32.6	34.2	34.8	36.4	39.0	40.0	40.9	45.1
Indiana-Illinois.....	40.3	45.3	46.0	46.3	47.9	50.3	55.5	55.1	54.1
Oklahoma-Kansas.....	33.3	36.0	37.7	40.5	42.4	46.3	49.0	50.0	50.6
Texas.....	23.3	25.3	23.7	26.5	30.8	33.9	36.9	39.0	39.7
Louisiana-Arkansas.....	25.4	25.0	23.5	24.6	24.2	21.5	24.3	27.0	28.6
Rocky Mountain.....	44.4	52.2	53.7	53.7	54.1	52.5	52.7	52.6	58.0
California.....	15.4	14.3	15.6	19.7	20.1	19.4	21.3	23.7	26.0
United States.....	26.1	27.1	28.8	30.0	31.2	32.4	34.9	36.0	37.5

Authority: Compiled from reports of U. S. Bureau of Mines.

PRODUCTION AND STOCKS OF GASOLINE BY REFINERY DISTRICTS
(Thousands of Barrels of 42 U. S. Gallons)

	1922	1923	1924	1925	1926	1927	1928
<i>Production:</i>							
East Coast.....	27,654	33,325	39,956	41,527	46,142	49,247	53,694
Appalachian.....	7,100	7,509	8,316	10,154	12,231	12,581	15,894
Indiana-Illinois, etc....	21,156	24,174	28,004	34,800	40,181	43,682	55,716
Oklahoma-Kansas, etc..	27,790	29,887	36,187	47,978	50,971	55,215	60,943
Texas.....	25,190	29,083	41,270	53,130	62,559	71,276	80,863
Louisiana-Arkansas....	8,710	10,320	12,417	14,996	21,239	24,006	26,662
Rocky Mountain.....	13,560	15,053	15,230	14,563	16,350	14,313	16,497
California.....	16,512	30,552	31,946	42,453	50,061	60,115	66,914
U. S. Total.....	147,672	179,903	213,326	259,601	299,734	330,435	377,183
Texas Gulf Coast.....	17,831	21,914	30,480	39,694	48,748	56,412	62,526
Louisiana Gulf Coast...	6,815	8,487	9,952	11,877	16,977	19,006	20,199
<i>Stocks End of Period:</i>							
East Coast.....	4,446	5,864	4,868	8,039	7,385	4,748	5,537
Appalachian.....	484	599	635	770	846	1,035	1,229
Indiana-Illinois, etc....	2,472	2,689	3,789	4,177	4,357	3,734	5,099
Oklahoma-Kansas, etc..	3,822	3,290	2,882	2,822	3,096	2,983	3,691
Texas.....	2,827	3,509	3,677	4,865	5,002	4,889	4,863
Louisiana-Arkansas....	2,168	2,609	2,047	5,014	3,259	1,491	2,158
Rocky Mountain.....	2,458	2,466	2,758	3,911	4,137	1,643	1,568
California.....	2,366	6,988	10,167	9,277	10,941	12,793	8,921
U. S. Total.....	21,043	28,014	30,823	38,875	39,023	33,316	33,066
Texas Gulf Coast.....	2,515	3,273	3,247	4,280	4,569	4,197	4,063
Louisiana Gulf Coast...	2,111	2,548	1,930	4,911	3,196	1,413	1,979

Authority: U. S. Bureau of Mines.

PRODUCTION AND STOCKS OF KEROSENE BY REFINERY DISTRICTS
(Thousands of Barrels of 42 U. S. Gallons)

	1922	1923	1924	1925	1926	1927	1928
<i>Production</i>							
East Coast.....	13,220	13,478	13,743	13,665	12,331	10,413	8,563
Appalachian.....	3,400	3,606	3,495	3,407	4,211	3,836	5,719
Indiana-Illinois, etc....	4,724	5,164	5,703	6,131	4,937	5,260	6,318
Oklahoma-Kansas, etc..	7,898	6,679	8,123	9,090	8,901	9,123	10,239
Texas.....	13,343	12,757	13,310	13,360	15,806	13,892	14,494
Louisiana-Arkansas....	5,033	6,073	6,190	5,461	6,673	6,129	5,814
Rocky Mountain.....	2,645	3,024	2,364	2,207	2,108	1,864	1,829
California.....	4,650	5,146	7,098	6,368	6,801	5,596	9,180
U. S. Total.....	54,913	55,927	60,026	59,689	61,768	56,113	60,156
<i>Stocks End of Period:</i>							
East Coast.....	2,008	1,735	1,692	1,275	1,664	1,401	1,288
Appalachian.....	315	312	304	232	245	316	312
Indiana-Illinois, etc....	944	936	855	857	778	1,004	1,286
Oklahoma-Kansas, etc..	732	419	765	381	677	605	729
Texas.....	1,304	1,371	2,349	1,969	2,066	1,322	1,565
Louisiana-Arkansas....	597	1,092	878	307	1,129	937	946
Rocky Mountain.....	134	158	219	327	383	350	366
California.....	658	1,208	1,532	1,773	1,633	1,780	2,509
U. S. Total.....	6,692	7,231	8,594	7,121	8,575	7,715	9,001
Texas Gulf Coast.....	888	839	1,955	1,570	1,467	1,236	1,472
Louisiana Gulf Coast...	553	1,065	850	301	1,116	911	927

Authority: U. S. Bureau of Mines.

PRODUCTION AND STOCKS OF GAS AND FUEL OIL BY REFINERY DISTRICTS
(Thousands of Barrels of 42 U. S. Gallons)

	1922	1923	1924	1925	1926	1927	1928
<i>Production:</i>							
East Coast.....	49,297	57,444	68,010	58,925	59,972	74,458	94,023
Appalachian.....	4,940	4,788	4,578	5,761	6,776	6,997	7,271
Indiana-Illinois, etc....	15,401	15,852	17,480	18,510	19,344	21,850	32,715
Oklahoma-Kansas, etc..	31,948	30,111	32,095	37,128	33,053	33,653	37,193
Texas.....	53,548	50,426	58,046	66,033	64,773	72,304	79,349
Louisiana-Arkansas....	15,275	17,348	23,034	37,358	34,393	31,548	33,954
Rocky Mountain.....	12,314	13,910	12,540	11,208	8,160	7,348	7,100
California.....	72,187	97,602	104,693	130,068	138,724	144,908	134,150
U. S. Total.....	254,910	287,481	320,476	364,991	365,195	393,066	425,755
Texas Gulf Coast.....	42,133	39,284	43,015	48,610	49,074	55,277	56,227
Louisiana Gulf Coast...	11,081	12,301	14,311	26,053	19,519	17,883	19,256
<i>Stocks End of Period:</i>							
East Coast.....	6,174	6,281	4,875	5,492	6,519	11,209	5,360
Appalachian.....	606	876	520	586	788	1,068	1,190
Indiana-Illinois, etc....	628	1,060	843	1,002	1,145	1,434	2,771
Oklahoma-Kansas, etc..	2,622	1,934	3,154	3,905	5,008	5,205	6,385
Texas.....	7,403	8,341	6,622	8,113	8,026	10,767	11,952
Louisiana-Arkansas....	4,969	1,344	3,040	3,995	2,256	3,681	6,070
Rocky Mountain.....	861	684	502	1,588	1,156	658	1,198
California.....	7,802	15,552	20,218	*85,783	*87,270	*93,719	*99,975
U. S. Total.....	31,065	36,072	39,774	110,464	112,168	127,741	134,901
Texas Gulf Coast.....	6,298	7,553	5,122	6,950	6,996	9,044	9,242
Louisiana Gulf Coast...	4,704	1,215	2,666	3,169	1,590	3,120	5,033

* Includes heavy crude oil and all grades of fuel oil in California.

Authority: U. S. Bureau of Mines.

PRODUCTION AND STOCKS OF LUBRICANTS BY REFINERY DISTRICTS
(Thousands of Barrels of 42 U. S. Gallons)

	1922	1923	1924	1925	1926	1927	1928
<i>Production:</i>							
East Coast.....	7,278	7,476	8,064	9,189	9,567	10,144	10,817
Appalachian.....	3,772	3,988	4,265	4,511	4,799	4,410	5,109
Indiana-Illinois, etc....	1,810	2,526	2,514	3,207	3,268	3,309	3,943
Oklahoma-Kansas, etc..	1,793	1,956	2,220	2,518	2,480	2,365	2,639
Texas.....	5,482	6,808	6,666	7,716	8,043	7,849	8,361
Louisiana-Arkansas....	777	611	761	793	832	741	769
Rocky Mountain.....	448	457	470	587	640	590	620
California.....	1,944	2,306	2,538	2,534	2,664	2,313	2,401
U. S. Total.....	23,304	26,128	27,498	31,055	32,293	31,721	34,659
<i>Stocks End of Period:</i>							
East Coast.....	2,198	2,383	2,151	2,687	2,599	2,629	2,773
Appalachian.....	876	728	815	844	993	1,095	1,220
Indiana-Illinois, etc....	556	647	606	793	647	840	805
Oklahoma-Kansas, etc..	382	234	394	444	423	512	480
Texas.....	1,117	1,212	1,376	1,387	1,773	1,671	1,899
Louisiana-Arkansas....	59	83	161	108	119	114	103
Rocky Mountain.....	88	137	132	174	150	127	181
California.....	337	714	785	816	872	872	879
U. S. Total.....	5,613	6,138	6,420	7,253	7,576	7,860	8,340
Texas Gulf Coast.....	1,106	1,209	1,357	1,348	1,738	1,606	1,817
Louisiana Gulf Coast...	59	78	145	107	119	113	101

Authority: U. S. Bureau of Mines.

WAX PRODUCTION AND CONSUMPTION

(Thousands of Pounds)

	Production	Imports	Exports	Stocks end of year	Domestic demand
1918.....	505,144	5,647	235,543	199,658	210,650
1919.....	467,235	9,883	263,345	222,462	190,969
1920.....	541,405	7,629	375,276	195,368	180,852
1921.....	433,887	4,546	225,881	207,563	200,357
1922.....	462,003	7,447	284,501	204,891	187,621
1923.....	466,647	12,843	329,793	164,758	189,830
1924.....	516,491	867	382,820	89,706	221,590
1925.....	590,577	14,588	334,179	116,391	244,301
1926.....	645,815	9,983	335,584	167,214	251,274
1927.....	584,347	20,462	340,423	*150,638	282,503
1928.....	630,144	24,748	391,623	110,344	303,563

* New basis of figuring wax stock. This is 1927 figure and is comparable with 1928.

Authority: U. S. Bureau of Mines.

ASPHALT PRODUCTION FROM PETROLEUM

Year	Tons	Year	Tons
1918.....	607,968	1923.....	2,327,116
1919.....	901,885	1924.....	2,545,573
1920.....	1,290,614	1925.....	2,677,400
1921.....	1,214,536	1926.....	2,922,788
1922.....	1,895,257	1927.....	3,417,700
		1928.....	3,297,000

Authority: U. S. Bureau of Mines.

PETROLEUM COKE PRODUCTION

Year	Tons	Year	Tons
1918.....	559,663	1923.....	672,526
1919.....	603,459	1924.....	761,095
1920.....	576,613	1925.....	991,000
1921.....	604,465	1926.....	995,308
1922.....	707,064	1927.....	1,145,200
		1928.....	1,426,600

Authority: U. S. Bureau of Mines

GASOLINE FROM NATURAL GAS

An increasingly important source of gasoline is natural gas, which is supplementing the supply derived from crude petroleum. In 1927, the production of natural gasoline (according to the U. S. Bureau of Mines) amounted to 1,641,144,000 gallons, as compared with 282,536,000 gallons produced as recently as 1918.

The development of this source of supply ranks only second to "cracked" gasoline, derived from fuel oil and gas oil, in its importance in supplying the tremendous demands of the motorist and in forestalling a shortage. Commercial natural gasoline production dates from 1911. The gas from petroleum and natural gas wells is treated by two principal methods, absorption and compression. The raw gasoline derived is a very volatile product. New methods of rectification have been developed which now make it possible to produce natural gasoline suitable for use in high compression airplane motors, but the major portion of the natural gasoline produced is used for blending with petroleum gasoline of low volatility, thus making available for motor use a quantity of motor fuel in excess of natural production.

The utilization of natural gas for making gasoline constitutes one of the most important achievements of the industry toward conservation. Formerly, most of the gas coming out of oil wells was permitted to escape into the air. In recent years, the building of natural gasoline plants to take care of this gas has become an integral part of lease operations throughout the country.

Making gasoline from natural gas is an industry apart from the manufacture of gasoline from petroleum, although closely related.

NATURAL GASOLINE PRODUCED IN THE UNITED STATES, 1926 AND 1927, BY STATES

State	Number of operators reporting ¹	Number of plants	Raw (unblended) gasoline produced			Estimated quantity of natural gas treated	
			Thousands of gallons	Value at plant		Millions of cubic feet	Average yield per M cubic feet (gallons)
				Thou- sands of dollars	Average per gallon (cents)		
1926							
Alaska	1	1	33	4	12.1	25	1.3
Arkansas	10	16	30,385	2,867	9.4	20,903	1.5
California	65	172	389,366	245,945	11.8	284,365	1.4
Colorado	1	3	276	17	6.2	90	.7
Illinois	26	82	9,987	967	9.7	3,674	2.7
Kansas	14	21	25,369	2,105	8.3	30,801	.8
Kentucky	10	12	7,689	914	11.9	26,521	.3
Louisiana	26	44	43,557	3,692	8.5	111,537	.4
New Mexico . . .	1	1	1,488	146	9.8	884	1.7
New York	4	4	539	66	12.2	500	1.1
Ohio	21	40	10,817	1,402	13.0	45,533	.2
Oklahoma	94	297	475,716	41,433	8.7	235,157	2.0
Pennsylvania . .	90	141	20,343	2,454	12.1	63,819	.3
Texas	50	134	243,093	22,760	9.4	181,243	1.3
West Virginia	44	123	63,807	7,706	12.1	166,135	.4
Wyoming	8	11	40,625	3,934	9.7	34,813	1.2
	1390	1,102	1,363,090	136,412	10.0	1,206,300	1.1
1927							
Alaska	1	1	19	2	10.5	15	1.3
Arkansas	12	16	37,498	2,281	6.1	20,566	1.8
California	50	152	498,020	52,436	10.5	332,676	1.5
Colorado	2	2	912	64	7.0	1,455	.6
Illinois	27	83	8,853	532	6.0	3,582	2.5
Kansas	15	25	36,095	1,746	4.8	28,906	1.2
Kentucky	10	12	7,480	547	7.3	27,994	.3
Louisiana	29	49	44,844	2,442	5.4	118,191	.4
New Mexico . . .	1	1	1,827	109	6.0	998	1.8
New York	3	3	449	38	8.5	539	.8
Ohio	21	39	12,167	1,062	8.7	42,623	.3
Oklahoma	98	302	548,109	29,114	5.3	262,703	2.1
Pennsylvania . .	98	147	16,744	1,648	9.8	47,424	.4
Texas	57	152	320,723	18,347	5.7	265,699	1.2
West Virginia	44	125	64,192	5,421	8.4	152,297	.4
Wyoming	8	10	43,212	2,899	6.7	35,580	1.2
	1394	1,119	1,641,144	118,688	7.2	1,341,248	1.2

¹ A producer operating in more than one state is counted only once.² Estimated.

Authority: U. S. Bureau of Mines.

NATURAL GASOLINE PRODUCED IN THE UNITED STATES, 1918-1927, BY STATES
(Thousands of Gallons)

Year	Arkansas	California	Colorado	Illinois	Kansas	Kentucky	Louisiana	New Mexico	New York
1918	.....	32,269	2	4,575	2,390	3,331	7,021	....	218
1919	.....	40,386	...	6,060	3,284	5,136	10,063	....	458
1920	.....	48,208	...	6,055	4,331	4,497	10,610	....	411
1921	.....	58,220	...	7,536	3,587	4,242	15,341	....	366
1922	4,289	67,120	...	7,760	2,856	5,205	29,406	....	506
1923	16,183	173,329	...	7,356	8,775	7,601	40,720	....	408
1924	17,533	232,579	...	9,091	11,658	7,274	48,098	....	477
1925	19,686	303,180	35	9,874	19,592	7,685	43,489	....	414
1926	30,385	389,366	276	9,987	25,369	7,689	43,557	1,488	539
1927	37,498	498,020	912	8,853	36,095	7,480	44,844	1,827	449

Year	Ohio	Oklahoma	Pennsylvania	Texas	West Virginia	Wyoming	Alaska	Total		
								Thousands of gallons	Value at plant	
									Thousands of dollars	Average per gallon (cents)
1918	6,745	163,701	15,775	7,326	37,604	1,579	..	282,536	50,364	17.8
1919	8,801	189,995	20,284	9,337	52,150	5,581	..	351,535	64,197	18.3
1920	10,016	178,857	21,151	32,956	58,941	8,711	..	384,744	71,788	18.7
1921	9,100	185,341	19,856	77,141	54,646	14,558	..	449,934	61,815	13.7
1922	8,600	189,404	18,518	95,405	56,796	19,967	..	505,832	72,711	14.4
1923	10,035	270,249	19,132	177,765	63,381	21,292	..	816,226	77,268	9.5
1924	9,443	301,062	19,254	186,571	61,549	29,272	..	933,861	82,233	8.8
1925	8,701	390,861	18,850	214,092	58,201	32,777	33	1,127,470	120,383	10.7
1926	10,817	475,716	20,343	243,093	63,807	40,625	33	1,363,090	136,412	10.0
1927	12,167	548,109	16,744	320,723	64,192	43,212	19	1,641,144	118,688	7.2

Authority: U. S. Bureau of Mines.

USES OF PETROLEUM

SWEEPING CHANGES BROUGHT ABOUT BY PETROLEUM

With the exception of the art of printing, it may well be doubted if any single industry has brought so many and sweeping changes to the world as has the modern production and use of petroleum. None, perhaps, has wrought its revolution in manners, customs, modes of life, relations of the individual to the social establishment, in so short a period of time as has the industry of petroleum, along with those others that are collateral to and dependent upon it. Earliest among the general uses of petroleum was its service as an illuminant. Do we quite realize that the most blessed privilege which modern progress has given to man is the ability to make light where there was darkness?

The world never knew an adequate illuminant available to all the people until it found it in kerosene. That was in itself a revolution. It was not so spectacular as the later development of the internal combustion engine, which made the motor car possible; but it was probably quite as important in its influence for extension of knowledge, widening of opportunity for reading, study and education, expansion of culture, and an addition to the privileges and pleasures of life.

LIGHT AND CIVILIZATION

Not only that, but the whole mode of life in cities was changed when it became possible effectively to light their streets at night. The ancient and medieval cities were veritable hot-beds of crime, breeding places of revolution, headquarters of armed factions bent on robbery, murder and all violence so long as these things were possible in the darkness of night. When the light of real civilization burst upon the world, it showed first from the street corner lamp-

post. It warned evil doers that the deeds of the night could no longer be done in darkness.

Read any old account of nocturnal lawlessness in the great cities if you would be convinced how great an advance toward order and security was made possible by the proper lighting of streets. And that was brought about by the discovery of petroleum. The country town with kerosene or gasoline lamps, the city with gas lights, or the metropolis bathed in the electric radiance of the Great White Way—all depended at last on petroleum, which is essential to the manufacture of gas and to the operation of the vast mechanical plants that produce electric current.

PETROLEUM AND THE AGE OF MACHINERY

We shall not understand the service of this still mysterious fluid unless we try to picture a world as it was before light came into it, or a world as it would be even today, if it were deprived of the lighting facilities that have so vitally changed its ways of existence.

Then, we think of our mechanical age as the period of the greatest, most rapid and spectacular advance in human welfare; but this age of machinery would have been impossible but for petroleum to lubricate the wheels and gears, the flying spindles, the steam-driven Titans of power—the railroad's locomotive and the giant power plants of our ocean-going ships. With all our progress, all our technical and scientific accomplishments, we have found no substitute for petroleum as handmaiden to the vast mechanisms of the factory age.

Or, if this seems too broad a statement, go back to the cold and unemotional report of the engineers and industrial authorities who have told the story of Germany in wartime. There was an empire in life and death struggle, its every resource under tribute; and at the last its greatest need was lubricants for its machinery, gasoline for its air navy—the products of petroleum without which it is equally impossible to wage war or to maintain the arts of peace on the scale that modern conditions have dictated.

OIL AND THE MOTOR CAR

We have not mentioned that most obvious and universally recognized service that petroleum has rendered in making the motor car possible; through which life in the country has been revolutionized; quick and inexpensive transportation has been afforded to the people everywhere; distance has been well nigh eliminated as a factor in social and business relations. Our generation understands this part of petroleum's service far better than it does the other phases to which we have referred; the change has been brought about within our easy recollection.

We have seen the revolution in its making and in its accomplishment. We can remember, for it is only as yesterday, when limitations of transport and highways made country life an experience of isolation and loneliness; when the privileges of church and school, of community gatherings, of intimate acquaintance were denied to the great rural community. We know how great is the change, for we have seen it wrought within our day.

CONTINENT CONVERTED INTO A NEIGHBORHOOD

We have seen a continent converted into a neighborhood by the multiplication of petroleum-driven vehicles and the construction of modern roads. We have seen a million tractors enlisted in the service of the farmers to plow their land and cultivate their crops, thresh their grain, and haul their produce to market. We have seen individual lighting and water pumping plants installed in ever increasing numbers on the farm, driven by the power of petroleum, to lessen the drudgery of the housewife and to multiply the comforts and enjoyments of existence for the entire family. We have seen the rural school system broadened and bettered and lifted out of stagnation and inefficiency, thanks to the betterment of highways, the operation of public school busses, the consolidation of schools, the grading and efficient instruction of their pupils.

In a word, the automobile, made possible by the utilization of petroleum, has within our time carried to the country nearly every advantage that had formerly been monopolized by the city.

FIELDS OF UTILIZATION

There is probably no raw material which enters into as many fields of utilization as petroleum. Heat, light, power and lubrication are its principal uses, covering a range that makes petroleum as a raw material the most essential product of the present industrial age. Add to these the multiplication of ways that derivatives of petroleum, either alone or compounded with other materials, enter the daily life of the people, and some conception of the dominating importance of petroleum is gained.

When crude petroleum is subjected to refining processes the first gases to rise are the hydrocarbons. These yield a variety of products which enter into commerce and the arts. Among these are fuel gas, which is utilized for burning under boilers at the refineries, and another derivative, gas black, which is used in the making of rubber tires, inks and paints. A series of alcohols, including isopropyl, secondary butyl, secondary amyl and secondary hexyl are also recovered from these gases, which enter into the hospital and the home and are utilized as solvents for the making of lacquers, soaps and essential oils. Liquefied gases, also yielded from the hydrocarbon gases, are utilized in metal cutting and for illumination. Another product, petroleum ether, is used for priming motors and for laboratory work. Natural gasoline, also thus derived, yields light naphthas which, in turn, yield gas machine gasoline; pentane, used for candle power standardization; hexane, utilized in laboratories; and chemical solvents for drug extraction.

So-called white distillates, next derived from the refining of crude petroleum, include the naphthas and kerosene. From the naphthas are derived aviation gasoline, motor gasoline, commercial solvents, blending naphtha, varnish-makers' and painters' naphtha and dyers' and cleaners'

benzine. The refined oils, including kerosene, are used for illuminating oil, stove oil, tractor oil, signal oil by railroads and lighthouses, and mineral seal oil for coach and ship illumination and for gas absorption.

The next important product is furnace oil, used as a fuel in oil burning furnaces in office buildings and homes.

Intermediate distillates, next derived, yield gas oil and absorber oil. Gas oil is used by gas manufacturing plants in the carburation of water gas; is an important metallurgical fuel; yields gasoline by the "cracking" process and also Diesel fuel oil. Absorber oil enters into gasoline and benzol recovery.

From the heavy distillates next derived come technical heavy oils, waxes and lubricating oil. Technical heavy oils, upon treating, are made into a variety of products. From one of these—white oils—is derived so-called technical oil, used for lubricating special machinery, such as bakers' and candymakers' machinery, and for packing fruit and eggs; also medicinal oil for internal and external use and for the manufacture of salves, creams and ointments. Ink oils are derived from technical heavy oil; also saturating oil, which enters into wool and twine manufacture; emulsifying oil; electrical oils, used for transformers and switches; and flotation oils, used in metal recovery processes.

From heavy distillates are derived waxes which are used for making candles, chewing gum and candy. Wax also enters the laundry as a detergent and as an iron wax; has a wide use for sealing purposes, such as for the preserving of fruits and vegetables, and is used by etchers. Saturating wax is applied to cardboard, matches, and paper.

Lubricating oils derived from petroleum are used wherever there is machinery, special oils or compounds being made for different types.

From the residues of distillation are derived greases, such as gear grease, switch grease, and cup grease. By a refining process petrolatum is derived from greases. This enters the medicinal field, compounded with other products, in the form

of salves, creams and ointments and as petroleum jelly. It is also used for metal coating and lubrication. Residual fuel oil is used for burning under boilers in industrial plants, on ships and in railroad locomotives. Fuel oil is also used for making gasoline by "cracking" processes. Road oil is a residual product of petroleum, as are asphalts and pitches used for roofing, paving, felt saturating, bricquetting, rubber making and plastic composition. Another product is coke used for making carbon brushes, carbon electrodes, and also consumed as fuel.

From refinery sludges are made acid coke used as a fuel; sulphonic acid, utilized as a saponification and de-emulsifying agent; oils and pitches; and sulphuric acid, used in fertilizer manufacture.

UTILIZATION OF GASOLINE

ENORMOUS GROWTH IN GASOLINE USE

In 1919, there were 7,565,000 motor vehicles registered in this country. At the close of 1928, there were 24,493,124 cars. In 1919, 81,781,000 barrels of gasoline supplied the country's gasoline requirements. In 1928, the domestic consumption of gasoline was 327,252,000 barrels.

The increase in motor vehicles and gasoline consumption is shown in the following table:

Year	Number of automobiles registered at end of year	Domestic consumption of gasoline Barrels
1919.....	7,565,446	81,781,000
1920.....	9,231,941	101,207,000
1921.....	10,463,295	107,488,000
1922.....	12,238,375	127,905,000
1923.....	15,092,177	159,172,000
1924.....	17,593,677	185,005,000
1925.....	19,954,347	223,868,000
1926.....	22,001,393	261,813,000
1927.....	23,133,243	297,483,000
1928.....	24,493,124	327,252,000

GASOLINE CONSUMPTION BY STATES

In 1928, among states having gasoline taxes, California was the largest motor consumer of gasoline. Illinois and New York, large gasoline consuming states, did not levy gasoline taxes in 1928, and motor consumption figures for them are not available. Illinois and New York passed gasoline tax laws in 1929.

MOTOR GASOLINE CONSUMPTION BY STATES*
(Thousands of Gallons)

States	1928	1927
Alabama.....	168,276,000	147,225,000
Arizona.....	50,455,000	41,237,000
Arkansas.....	119,184,000	99,394,000
California.....	1,101,404,000	1,017,681,000
Colorado.....	142,015,000	129,184,000
Connecticut.....	182,307,000	159,953,000
Delaware.....	27,706,000	24,273,000
District of Columbia.....	63,579,000	57,804,000
Florida.....	224,704,000	247,248,000
Georgia.....	206,138,000	192,262,900
Idaho.....	50,148,000	42,343,000
Indiana.....	388,466,000	349,995,000
Iowa.....	306,651,000	309,098,000
Kansas.....	315,671,000	270,615,000
Kentucky.....	134,836,000	118,273,000
Louisiana.....	169,046,000	151,605,000
Maine.....	82,203,000	74,038,000
Maryland.....	143,375,000	131,500,000
Michigan.....	673,335,000	593,372,000
Minnesota.....	328,434,000	289,686,000
Mississippi.....	129,157,000	117,756,000
Missouri.....	355,001,000	323,052,000
Montana.....	74,272,000	53,248,000
Nebraska.....	198,446,000	169,677,000
Nevada.....	14,378,000	12,720,000
New Hampshire.....	48,235,000	†45,722,000
New Jersey.....	422,348,000	204,143,000
New Mexico.....	36,793,000	30,654,000
North Carolina.....	246,087,000	219,583,000
North Dakota.....	117,169,000	88,641,000
Ohio.....	860,631,000	770,658,000
Oklahoma.....	280,781,000	251,462,000
Oregon.....	144,283,000	130,885,000
Pennsylvania.....	759,027,000	691,557,000
Rhode Island.....	65,872,000	61,436,000
South Carolina.....	109,938,000	101,772,000
South Dakota.....	110,652,000	88,031,000
Tennessee.....	171,276,000	148,952,000
Texas.....	670,817,000	591,447,000
Utah.....	47,634,000	41,774,000
Vermont.....	37,312,000	33,167,000
Virginia.....	183,447,000	166,782,000
Washington.....	227,043,000	203,421,000
West Virginia.....	111,345,000	102,655,000
Wisconsin.....	357,146,000	313,586,000
Wyoming.....	31,794,000	26,218,000
Total.....	10,688,817,000	9,436,485,000

Authority: Compiled by American Petroleum Institute from records of states having gasoline tax or inspection laws.

* Figures based on gasoline consumed by motor vehicles and other taxable consumption. In a few instances small quantities of non-taxable gasoline are included.

† Last six months of year, as tax became effective July 4, 1927.

AUTOMOTIVE EXPANSION

The number of motor vehicles registered in the United States at the end of 1928 (according to the Bureau of Public Roads, U. S. Department of Commerce) was 24,493,124. This includes passenger cars and motor trucks. The expansion of the automotive industry, and the development of the use of motor vehicles, as tending to affect the use of gasoline, are shown in the following figures presented in "Facts and Figures of the Automobile Industry," 1929 edition, published by the National Automobile Chamber of Commerce.

MOTOR VEHICLE REGISTRATIONS

December 31	Passenger cars		Motor trucks		Total motor vehicles	
	Number	% Increase	Number	% Increase	Number	% Increase
1895.....	4	....	.....	....	4	....
1896.....	16	....	.....	....	16	....
1897.....	90	....	.....	....	90	....
1898.....	800	....	.....	....	800	....
1899.....	3,200	....	.....	....	3,200	....
1900.....	8,000	....	.....	....	8,000	....
1901.....	14,800	85%	.....	....	14,800	85%
1902.....	23,000	55%	.....	....	23,000	55%
1903.....	32,920	43%	.....	....	32,920	43%
1904.....	54,590	66%	410	....	55,000	67%
1905.....	77,400	42%	600	46%	78,000	42%
1906.....	105,900	37%	1,100	83%	107,000	37%
1907.....	140,300	33%	1,700	55%	142,000	33%
1908.....	194,400	38%	3,100	82%	197,500	39%
1909.....	305,950	57%	6,050	95%	312,000	58%
1910.....	458,500	50%	10,000	65%	468,500	50%
1911.....	619,500	35%	20,000	100%	639,500	36%
1912.....	902,600	46%	41,400	107%	944,000	48%
1913.....	1,194,262	32%	63,800	54%	1,258,062	33%
1914.....	1,625,739	36%	85,600	34%	1,711,339	36%
1915.....	2,309,666	42%	136,000	59%	2,445,666	43%
1916.....	3,297,996	43%	215,000	58%	3,512,996	44%
1917.....	4,657,340	42%	326,000	52%	4,983,340	42%
1918.....	5,621,617	21%	525,000	61%	6,146,617	23%
1919.....	6,771,074	21%	794,372	51%	7,565,446	23%
1920.....	8,225,859	22%	1,006,082	27%	9,231,941	22%
1921.....	9,346,195	14%	1,118,520	18%	10,464,715	13%
1922.....	10,864,128	16%	1,375,725	16%	12,239,853	17%
1923.....	13,479,608	24%	1,612,569	17%	15,092,177	23%
1924.....	15,460,649	15%	2,134,724	32%	17,595,373	17%
1925.....	17,512,638	13%	2,441,709	15%	19,954,347	14%
1926.....	19,237,171	10%	2,764,222	13%	22,001,393	10%
1927.....	20,219,224	5%	2,914,019	5%	23,133,243	5%
1928.....	21,379,125	6%	3,113,999	7%	24,493,124	6%

PRODUCTION AND WHOLESALE VALUE OF MOTOR VEHICLES

	Passenger cars		Motor trucks		Total cars and trucks	
	Number	Value	Number	Value	Number	Value
*1900	4,192	\$4,899,443	.....	.....	4,192	\$4,899,443
1901	7,000	8,183,000	.....	.....	7,000	8,183,000
1902	9,000	10,395,000	.....	.....	9,000	10,395,000
1903	11,235	13,000,000	.....	.....	11,235	13,000,000
*1904	22,419	23,682,492	411	\$946,947	22,830	24,629,439
1905	24,550	39,030,000	450	970,000	25,000	40,000,000
1906	33,500	61,850,000	500	1,050,000	34,000	62,900,000
1907	43,300	92,040,000	700	1,360,000	44,000	93,400,000
1908	63,500	135,250,000	1,500	2,550,000	65,000	137,800,000
*1909	127,731	159,918,506	3,255	5,230,023	130,986	165,148,529
1910	181,000	215,340,000	6,000	9,660,000	187,000	225,000,000
1911	199,319	225,000,000	10,681	21,000,000	210,000	246,000,000
1912	356,000	335,000,000	22,000	43,000,000	378,000	378,000,000
1913	461,500	399,902,000	23,500	44,000,000	485,000	443,902,000
*1914	543,679	413,859,379	25,375	45,098,464	569,054	458,957,843
1915	895,930	575,978,000	74,000	125,800,000	969,930	701,778,000
1916	1,525,578	921,378,000	92,130	161,000,000	1,617,708	1,082,378,000
1917	1,745,792	1,053,505,781	128,157	220,982,668	1,873,949	1,274,488,449
1918	943,436	801,937,925	227,250	434,068,992	1,170,686	1,236,106,917
1919	1,657,652	1,461,785,925	275,943	423,326,621	1,933,595	1,885,112,546
1920	1,905,560	1,809,170,963	321,789	423,249,410	2,227,349	2,232,420,373
†1921	1,529,165	1,095,883,000	153,200	165,783,550	1,682,365	1,261,666,550
†1922	2,397,827	1,571,569,041	248,402	221,453,667	2,646,229	1,793,022,708
†1923	3,780,358	2,282,953,822	400,092	309,079,606	4,180,450	2,592,033,428
†1924	3,327,770	2,049,101,671	410,016	318,311,344	3,757,786	2,367,413,015
†1925	3,904,566	2,555,419,483	523,234	459,744,079	4,427,800	3,015,163,562
†1926	3,984,018	2,758,446,322	521,643	456,371,169	4,505,661	3,214,817,491
†1927	3,093,428	2,269,056,222	486,952	431,649,521	3,580,380	2,700,705,743
†1928	4,024,590	2,708,954,674	576,540	453,844,206	4,601,130	3,162,798,880

* From U. S. Census reports. 1900 for fiscal year ended June 30, 1900.

† Figures include production of plants located in Canada.

TOTAL MOTOR VEHICLE REGISTRATIONS BY STATES

1923-1928

State	1923	1924	1925	1926	1927	1928
Alabama.....	126,642	157,262	194,580	225,930	243,539	269,519
Arizona.....	49,175	57,828	68,029	73,682	81,047	94,372
Arkansas.....	113,300	141,983	183,589	209,419	206,568	214,931
California....	1,100,283	1,319,394	1,440,541	1,600,475	1,693,195	1,799,890
Colorado.....	188,956	213,247	240,097	248,613	268,492	284,867
Connecticut...	181,748	217,236	250,669	263,235	281,521	309,792
Delaware.....	29,977	35,136	40,140	44,834	47,124	51,210
District of Columbia....	74,811	86,762	103,092	111,497	111,680	126,556
Florida.....	151,990	195,128	286,388	401,562	394,734	352,961
Georgia.....	173,889	207,688	248,093	277,468	300,635	318,856
Idaho.....	62,379	69,227	81,506	94,760	101,336	108,154
Illinois.....	969,331	1,119,236	1,263,177	1,370,503	1,438,985	1,504,359
Indiana.....	583,342	651,705	725,410	772,326	813,637	823,806
Iowa.....	571,061	616,128	659,202	698,998	704,203	733,466
Kansas.....	375,594	410,891	457,033	491,276	501,901	533,799
Kentucky.....	198,377	229,804	261,647	281,557	285,621	304,231
Louisiana.....	136,622	178,000	207,000	239,500	255,000	264,293
Maine.....	108,609	127,598	140,499	151,486	163,623	172,638
Maryland....	169,351	198,465	234,247	252,852	276,863	285,311
Massachusetts	481,150	570,578	646,153	690,190	694,107	726,295
Michigan.....	730,658	867,545	989,010	1,118,785	1,154,773	1,249,221
Minnesota....	448,187	503,437	569,694	630,285	646,682	673,573
Mississippi....	104,286	134,680	177,262	205,200	218,043	246,242
Missouri.....	476,598	540,500	604,166	654,554	682,419	712,965
Montana.....	73,828	79,695	94,656	103,958	112,735	126,035
Nebraska.....	286,053	308,715	338,719	366,773	373,912	391,355
Nevada.....	15,699	18,118	21,169	24,014	25,776	27,376
New Hampshire..	59,604	71,149	81,498	89,001	96,009	102,644
New Jersey...	430,958	504,470	580,554	651,415	712,396	758,430
New Mexico...	32,032	41,680	49,111	54,996	59,291	65,737
New York....	1,204,213	1,412,879	1,625,583	1,815,434	1,937,918	2,083,942
North Carolina	246,812	302,232	340,287	385,047	430,499	464,376
North Dakota..	109,266	117,346	144,972	157,822	160,701	173,525
Ohio.....	1,069,100	1,241,600	1,346,400	1,480,246	1,570,734	1,649,699
Oklahoma....	307,000	369,903	424,345	499,938	503,126	529,843
Oregon.....	165,962	192,615	216,553	233,568	244,572	248,118
Pennsylvania..	1,043,770	1,228,845	1,330,433	1,455,184	1,554,915	1,642,207
Rhode Island..	76,312	95,482	101,756	110,746	118,014	125,698
South Carolina	127,467	161,753	168,496	181,189	199,635	216,805
South Dakota..	131,700	142,396	168,028	168,230	169,552	191,374

TOTAL MOTOR VEHICLE REGISTRATION BY STATES—CONTINUED
1923-1928

State	1923	1924	1925	1926	1927	1928
Tennessee . . .	173,365	204,680	244,626	279,639	294,567	322,137
Texas	688,233	801,833	975,083	1,049,869	1,111,407	1,214,297
Utah	59,525	68,316	90,500	85,380	93,974	98,541
Vermont	52,776	61,179	69,576	74,063	79,527	86,231
Virginia	218,896	261,945	282,650	322,614	337,607	360,545
Washington . . .	258,264	295,443	328,442	363,279	384,583	402,875
West Virginia . .	157,924	191,085	217,589	227,836	245,819	251,556
Wisconsin	457,271	525,221	594,386	662,282	698,289	742,135
Wyoming	39,381	43,639	47,711	49,883	51,955	56,336
Totals	15,092,177	17,593,677	19,954,347	22,001,393	23,133,241	24,493,124

Authority: Figures as of December 31 from U. S. Bureau of Public Roads

INCREASE IN PASSENGER CARS

Over a period of seven years the use of automotive passenger cars has increased 215 per cent.

REGISTRATION OF PASSENGER CARS IN U. S.

Year	Number	Year	Number
1919	6,771,074	1924	15,460,649
1920	8,225,859	1925	17,512,638
1921	9,346,195	1926	19,237,171
1922	10,864,128	1927	20,230,429
1923	13,479,608	1928	21,379,125

YEAR-ROUND OPERATION OF PASSENGER CARS

During recent years there has been a notable demand for closed passenger cars, making possible all-year-round operation and thus, in turn, increasing gasoline demand per motor car. In 1919, only 10.3 per cent of the cars produced were closed cars. Each year since, the proportion of closed cars manufactured has increased until, in 1928 it amounted to 88.5 per cent of the total.

PER CENT OPEN AND CLOSED CARS BY YEARS
(U. S. and Canada)

	Open	Closed	% Closed		Open	Closed	% Closed
1919* . . .	1,496,652	161,000	10.3%	1924 . . .	1,897,024	1,430,746	43.0%
1920* . . .	1,581,610	323,950	17.0%	1925 . . .	1,698,808	2,205,758	56.5%
1921 . . .	1,191,220	337,945	22.1%	1926 . . .	1,115,380	2,868,638	72.0%
1922 . . .	1,675,037	722,790	30.0%	1927 . . .	532,305	2,561,123	82.8%
1923 . . .	2,495,058	1,285,300	34.0%	1928 . . .	460,128	3,564,462	88.5%

* United States only.

INCREASE IN MOTOR TRUCKS

Over a period of ten years, the use of motor trucks has increased nearly 300 per cent.

REGISTRATION OF MOTOR TRUCKS

Year	Number	Year	Number
1919.....	794,372	1924.....	2,133,028
1920.....	1,006,082	1925.....	2,441,709
1921.....	1,118,520	1926.....	2,764,222
1922.....	1,375,725	1927.....	2,896,886
1923.....	1,612,569	1928.....	3,113,999

The National Automobile Chamber of Commerce estimates that 70 railroads now are making regular use of motor trucks for freight and other service.

BUSES IN UNITED STATES

(As of January 1)

	1925	1926	1927	1928	1929
Common Carrier Operations					
Motor carriers.....	31,100	31,975	34,000	35,000	35,182
Electric railways and subsidiaries	3,000	5,150	7,248	8,492	10,062
Steam railroads and subsidiaries	*	375	522	994	1,256
Total common carriers.....	34,100	37,500	41,806	44,486	46,500
Interstate buses (included in above figures).....	None	1,500	2,500	3,200	3,750
Non-Common Carrier Operations					
Schools (public and private)....	15,000	27,000	32,800	35,900	40,875
Sightseeing and tour companies..	1,500	2,500	2,650	2,750	2,750
Hotel.....	1,000	1,000	1,050	1,000	800
Industrial uses.....	1,075	1,075	1,100	1,100	1,000
Miscellaneous.....	250	350	400	400	400
Total non-common carriers....	18,825	31,925	38,000	41,150	45,825
Grand total all classes (estimated).....	52,952	69,425	79,806	85,636	92,325

Authority: "Bus Transportation"

* Not classified.

TOTAL HIGHWAY MILEAGE BY STATES

TOTAL EXISTING MILEAGE OF RURAL ROADS IN UNITED STATES (END OF 1927)
AND TOTAL MILES OF SURFACED ROADS

States	Total mileage			Miles surfaced roads		
	Total rural roads	State highways	Local roads	Total surfaced	State highways	Local roads
Alabama.....	63,706	3,919	59,787	18,204	2,384	15,820
Arizona.....	21,666	2,041	19,625	3,150	1,466	1,684
Arkansas.....	74,545	8,506	66,039	6,269	4,426	1,843
California.....	85,156	6,573	78,583	23,665	3,689	19,976
Colorado.....	68,279	9,095	59,184	6,383	3,770	2,613
Connecticut....	13,987	1,966	12,021	3,379	1,851	1,528
Delaware.....	3,796	629	3,167	927	629	298
Florida.....	29,583	6,339	23,244	13,735	3,218	10,517
Georgia.....	98,462	6,380	92,082	13,015	3,505	9,510
Idaho.....	37,349	4,219	33,130	7,940	2,159	5,781
Illinois.....	97,620	9,890	87,730	18,118	5,069	13,049
Indiana.....	73,609	4,364	69,245	50,284	4,349	45,935
Iowa.....	103,634	7,078	96,556	11,811	4,442	7,369
Kansas.....	129,246	7,922	121,324	3,609	1,983	1,626
Kentucky.....	61,261	9,647	51,614	15,618	4,525	11,093
Louisiana.....	33,120	7,979	25,141	9,501	5,225	4,276
Maine.....	21,002	1,788	19,214	4,832	1,495	3,337
Maryland.....	14,711	2,519	12,192	5,307	2,519	2,788
Massachusetts..	19,348	1,590	17,758	8,485	1,565	6,920
Michigan.....	81,016	7,144	73,872	22,493	6,108	16,385
Minnesota.....	110,249	6,936	103,313	32,398	6,543	25,855
Mississippi....	56,775	6,723	50,052	12,587	4,129	8,458
Missouri.....	110,547	7,482	103,065	11,739	3,913	7,826
Montana.....	66,881	7,957	58,924	2,799	1,075	1,724
Nebraska.....	93,903	6,167	87,736	3,979	3,340	639
Nevada.....	23,659	3,552	20,107	1,796	1,319	477
New Hampshire..	12,025	2,310	9,715	2,391	2,070	321
New Jersey.....	16,677	1,821	14,856	8,057	1,659	6,398
New Mexico....	48,217	9,253	38,964	2,144	1,793	351
New York.....	79,489	13,929	65,560	29,481	10,204	19,277
North Carolina..	71,530	7,083	64,447	27,811	6,226	21,585
North Dakota...	106,794	7,185	99,609	2,365	1,727	638
Ohio.....	84,753	11,000	73,753	43,977	9,896	34,081
Oklahoma.....	123,627	6,142	117,485	3,300	1,834	1,466
Oregon.....	51,658	4,393	47,265	11,814	3,409	8,405
Pennsylvania...	91,241	12,167	79,074	24,533	8,827	15,706

TOTAL HIGHWAY MILEAGE BY STATES—CONTINUED

TOTAL EXISTING MILEAGE OF RURAL ROADS IN UNITED STATES (END OF 1927)
AND TOTAL MILES OF SURFACED ROADS

States	Total mileage			Miles surfaced roads		
	Total rural roads	State highways	Local roads	Total surfaced	State highways	Local roads
Rhode Island...	2,538	867	1,671	853	479	374
South Carolina...	56,129	5,592	50,537	13,841	4,522	9,319
South Dakota...	120,265	6,015	114,250	4,087	2,896	1,191
Tennessee.....	64,490	5,033	59,457	12,521	3,709	8,812
Texas.....	188,564	18,728	169,836	23,117	9,271	13,846
Utah.....	23,416	3,436	19,980	3,001	1,388	1,613
Vermont.....	15,036	4,226	10,810	4,692	3,245	1,447
Virginia.....	57,535	5,245	52,290	11,192	4,156	7,036
Washington....	46,835	3,300	43,535	16,655	2,670	13,985
West Virginia...	34,799	3,820	30,979	3,713	2,210	1,503
Wisconsin.....	79,528	10,280	69,248	25,792	8,646	17,146
Wyoming.....	45,328	3,123	42,205	1,361	1,033	328
Total 1927...	3,013,584	293,353	2,720,231	588,721	176,566	412,155
Total 1928...	3,013,584	293,353	2,720,231	625,000	187,500	437,500

NOTE—The subdivision by States is for the calendar year 1927, the latest available figures. Grand totals have been estimated for 1928 as given above.

(Figures from U. S. Bureau of Public Roads)

U. S. EXPORTS OF MOTOR VEHICLES TO CONTINENTS

Country	1928		1927		1926	
	Cars	Trucks	Cars	Trucks	Cars	Trucks
Europe.....	110,858	41,236	79,880	25,479	47,116	17,207
North America.....	69,663	14,525	51,946	10,698	46,940	9,719
South America.....	78,540	36,132	58,292	26,314	54,175	14,219
Asia.....	35,152	18,978	21,290	10,175	17,324	5,056
Oceania.....	53,569	20,331	51,351	26,182	62,362	17,517
Africa.....	27,646	9,132	23,329	8,183	17,526	4,456
Total.....	375,428	140,334	286,088	107,031	245,443	68,174

Motor vehicles shipped as "parts for assembly" have not been included in the above table. Totals of these are as follows: 1926, passenger cars 48,676, trucks, 30,600; 1927, cars 45,948, trucks, 27,317; 1928, cars 43,472, trucks 23,497.

Authority: Bureau of Foreign and Domestic Commerce.

GROWTH OF AVIATION

Twenty-six years have passed since the epochal flights of Wilbur and Orville Wright with the first practical power airplane of man-carrying size. From the dreams of centuries these brothers fabricated the airplane of actuality. The airplane has come into its own. Its application in civil life, argued and urged by the pioneers, has been achieved.

The airways of the world showed a greater mileage than did the railroads on their silver anniversary.

At the close of 1926, the first year of contract air mail and the first year of what might be called American air transport, our operations compared favorably with those of the eight-year-old air transport net of Europe.

At the end of the next year there were in operation, or contracted for early service, thirty mail and other air lines with a mileage of 12,517 on which the daily flying totals 27,986 miles. All but two of these routes fly one airplane each way each day. Between New York and Chicago this service is doubled, and on the Detroit-Cleveland passenger route the service is twice daily in each direction.

The 123 routes of Europe were flying a daily mileage of approximately 67,000 over 33,191 miles of airways on the same date.

On December 31, 1928, the number of U. S. routes in operation had increased to 46, with an airway mileage of 16,667.

By the delivery of a Wright airplane to the United States War Department in 1908, the first airplane to be bought by any government, and the demonstration flights of the Wrights in England, France, Germany, and Italy, there was awakened everywhere the idea of flight for civil purposes. Doctor Bell's Aerial Experiment Association and Curtiss in America; Vuia, Santos Dumont, Voisin, Farman, Bleriot, Pelterie, and Ferber in France; Ellehammer in Denmark; Cody and Bellamy in England; Grade in Germany; and others had all flown in their own machines and civil purchases had begun. From 1909 hundreds of airplanes, mostly replicas of the successful planes of that day, began to be built by experimenters or bought by novices throughout the country.

AIR ROUTES IN ACTUAL OPERATION IN UNITED STATES AND EUROPE

Item	1927		1926	
	United States	Europe	United States	Europe
Air Transport				
Airplane miles flown	² 5,809,999	³ 12,616,752	4,428,772	¹ 8,852,552
Passengers carried	² 8,572	³ 197,671	5,782	¹ 102,178
Express and freight carried (pounds)	² 2,261,507	³ 7,713,841	1,733,090	¹ 9,880,115
Mail carried (pounds)	1,654,165	³ 2,599,986	810,855	¹ 2,853,550
Miles of airways	9,028	³ 33,191	8,525	31,137
Miles of lighted airways	5,872	0	3,149	0
Number of routes	23	³ 123	⁵ 16	100
Average passenger rate per mile	\$0.106	⁶ \$0.08	\$0.12	\$0.08
Air Service				
Airplane miles flown	(⁷)	(⁶)	18,746,640	(⁶)
Passengers carried	(⁷)	(⁶)	771,010	(⁶)
Express and freight carried	(⁷)	(⁶)	418,936	(⁶)

¹ Statistics for England, France, Germany, Italy, and Netherlands.

² These figures may be increased with complete returns.

³ Statistics for England, France, Germany, Italy, Netherlands, Austria, Denmark, Poland, Sweden, and Switzerland.

⁴ This figure probably includes newspapers carried in some cases.

⁵ Transcontinental counted as 1 route.

⁶ No equivalent in Europe.

⁷ Statistics not yet compiled.

Authority: U. S. Department of Commerce, Aeronautics Branch

The airplane was such an obviously outstanding novelty that its exhibition in flight was the first widespread application to civil use. From the fall of 1909 until the war, scores of individuals and groups traveled throughout the country in exhibition and meets, some of the latter of which were of international character, and foreign contestants as well as Americans created new world records in various categories.

A number of passenger-carrying routes were conducted over short distances, and the airplanes had been demonstrated in forest fire detection, mail-carrying, and in numerous other normal and emergency applications, but there was little of what properly might be called civil and commercial aviation in the United States until after the World War.

In aerostation small exhibition airships were flown all over the country from 1902, and ballooning as a sport became popular after 1905 and continues to this day.

The immediate possibilities of the airplane for military purposes were realized and, save in America, the military demand predominated. In the United States it was not until 1917 that military purchases exceeded civil production. For three postwar years the sale of surplus military craft to civilian purchasers still left the Army and Navy as the greatest consumers of new airplanes. From 1923 the civil consumption again exceeded that of the military.

The effect of the world conflict on the development of civil aviation in the United States was profound. Many new aircraft factories had been built; hundreds of aeronautical engineers and designers were given an opportunity to demonstrate their skill; 10,000 pilots were taught to fly; nearly 17,000 planes were manufactured; scores of thousands of artisans became skilled in aircraft production; all of which created a personnel and material out of which was to develop the postwar aviation which differs so widely from European civil development.

With peace, no inconsiderable percentage of those who had been engaged in the manufacture of aircraft or trained as pilots became actively interested in the civil possibilities.

The "air service operator" sprang naturally out of the war experience. Hundreds of Army and Navy pilots, too young to have had much business experience, found themselves with a great desire to continue in the alluring field of flight. As the government had thousands of surplus planes and engines to be disposed of, these war pilots, with others, created a considerable market, and they soon developed into a nation-wide group of air propagandists largely responsible for such air-mindedness of the American people as exists today, while at the same time they were putting the airplane to useful work.

This war surplus of planes and engines thus enabled many hundreds of civilian and ex-service pilots finally to establish

themselves permanently in more or less profitable enterprises in as many towns of the country, carrying passengers on short rides, giving instruction in flying, doing aerial photography, making cross-country flights in response to emergency or other calls, and generally developing the commercial air service peculiar to the United States.

By the end of 1926 the war surplus of aircraft had become about exhausted, and there had been marketed a number of low-priced airplanes of entirely new construction still utilizing war surplus engines of low power. In 1927, the new construction doubled; the war surplus of engines neared exhaustion, and there was developed the cabin type of airplane especially designed for air transport, with modern higher powered engines.

The exhibition airship no longer exists, but ballooning continues popular.

The passage of the Kelly Air Mail Act was the stimulus for another phase of air operations which began in 1926—the established long-distance air route flown on schedule with mail, passengers, and express.

TODAY'S AIR COMMERCE

America today is doing a prodigious amount of civil flying. A great transcontinental system of air mail, express, and passenger service, rapidly growing, has been in actual operation for two years; air service operators are flourishing in hundreds of cities; executives are flying their own airplanes in the conduct of daily business; more than a thousand airports are in existence, and the manufacturing industry is behind on its orders.

These flying activities may be divided into three general classes: air transport, or scheduled traffic, over regular routes (mail, express, passenger); air service operations, such as taxi service, crop dusting, photography, over-city flights, tours, and other; and private, including pleasure aviation and the business travel of executives. The number of business men using airplanes in their daily affairs is rapidly growing.

UNITED STATES AIRWAY OPERATION STATISTICS

	1928	1927	1926
Miles flown.....	*10,000,000	5,870,489	4,318,087
Passengers carried.....	*35,000	8,679	5,782
Express carried (pounds).....	*2,500,000	2,263,580	1,733,090
Mail carried.....	3,959,452	1,654,165	810,855
Air mail income to contractors.....	\$7,430,225	\$2,653,454	\$765,549
Routes operated.....	46	23	16
Airways, length (miles).....	16,667	9,189	8,410
Airways lighted.....	¹ 9,302	¹ 5,745	¹ 3,149

* Approximate figures.

¹ Airways lighted represent the number of miles lighted, also in course of installation on December 31, 1928, 1927 and 1926 respectively.

Authority: U. S. Department of Commerce, Aeronautics Branch.

To the surplus of aircraft at the conclusion of the war, and to the experience in the carrying of messages, mail and personnel by air during the war, may probably be ascribed the inauguration in Europe in 1919 of an airway system which now covers Central Europe and extends into Africa, Asia, and the far corners of the world.

A great passenger and express business has been developed in addition to air mail. In Europe the routes are supported in the main by subsidies in one form or another amounting to great sums annually. Many of these routes serve colonial possessions without regard to purely civil or commercial reasons. In America there is no subsidy.

As in Europe, there were prior to the World War no mail, passenger, or express air routes continuously operating in the United States, save for some seasonal short lines operated in the early years of aeronautics and for occasional few-day demonstrations by private or air service owners in cooperation with the Post Office Department at air meets and exhibitions.

For a brief period from May 15, 1918, an experimental air mail route was inaugurated between New York and Washington, D. C. For the first three months it was operated by the Army as an adjunct to training, but on August 10 the Post Office Department took over actual operation.

In 1919, the Post Office Department initiated plans for the transcontinental air mail route between New York, Chicago, and San Francisco, and actually began operation of planes between Cleveland and Chicago on May 15. On July 1 the operations were extended from Cleveland to New York. Army training planes were used until the end of the war, when surplus De Havillands were put into general service, many being remodeled for the purpose.

Beginning May 15, 1920, the line was extended west from Chicago to Omaha, and on September 8 flying began between Omaha and San Francisco, completing combination daylight airplane and night train service across the continent. The mail was flown out of New York and put on a train in the evening at Chicago; taken off the train the following morning, and flown the balance of the route. Eastward this procedure was reversed.

Through transcontinental service by air alone began July 1, 1924, after lighting that portion over which the air mail was carried by rail. Subsequently, lights were added between Chicago and New York on the east and between Cheyenne and Salt Lake City to the west.

The transcontinental continued in unbroken operation by the Post Office Department until contracted to private enterprise. The section between Chicago and San Francisco began operation as a contract route on July 1, 1927. The eastern half followed in September of the same year.

Another route from St. Louis to Minneapolis-St. Paul was operated by the Post Office Department beginning December 1, 1920, but was discontinued June 30, 1921, in order that all energies might be devoted to the transcontinental. In the meantime, radiotelegraphy had become a permanent feature of the government's air mail service for dispatching and weather service. On July 1, 1927, this equipment and its personnel were taken over by the Department of Commerce, under the provisions of the Air Commerce Act of 1926.

Save for that portion of the government's route between Salt Lake City and New York, lighted by the Post Office

Department (2041 miles), all civil airway flying in 1926 was done without lighting facilities. The economical use of the airplane demands flying by night as well as by day, and in all vicissitudes of weather and season; and it is the function of the Department of Commerce, under the Air Commerce Act of 1926, to furnish to air traffic those aids which will result in the greatest degree of flight efficiency. Lighting of the airways was undertaken as the first stage, and by the beginning of 1927 some lights were placed in operation. On December 31, 1928, there were 9,302 miles of airway lighting, including the 2,041 miles previously lighted by the Post Office Department.

Many especially designed mail planes had been purchased and put into service by the Post Office Department from time to time during its operation of the transcontinental, and at the time of its transfer to private enterprise the equipment consisted mainly of modern craft. The flying equipment was disposed of at auction, and those terminals which had been constructed by the Post Office Department were turned over to the municipalities. The intermediate fields and lighting equipment went to the Department of Commerce for future operation.

On October 15, 1920, foreign-mail contract routes were inaugurated between Seattle and Victoria in the Northwest and between Key West and Havana in the Southeast. The Seattle-Victoria route still continues operation. The Florida route was discontinued March 31, 1923, but resumed in 1927.

Another foreign contract air mail route began operation April 9, 1923, between New Orleans and Pilottown, La., and still continues. Both the Seattle and the New Orleans routes handle late mail to and from steamers and save many days by avoiding long delay waiting for the next boat.

A contract route was also operated between Fairbanks and McGrath, Alaska, from February 1, 1924, to June 30, 1924.

In the eleven fiscal years of American air mail, 1918 to 1928, Congress appropriated \$17,685,000 for government

routes and \$4,500,000 for domestic contract routes. In addition, moneys have been expended out of allotments for foreign-mail service (Alaska, New Orleans, Key West, and Seattle routes).

AIR MAIL SERVICE STATISTICS
(Government-operated routes only)

Fiscal year	Miles mail trips scheduled	Miles traveled with mail	Percentage miles flown with mail	Number letters carried (40 per pound)	Total miles flown, mail, ferry, and test	Forced landings	
						Mechanical	Weather
1918.	18,000	16,009	84	713,240	21,389	6	6
1919.	166,843	160,066	96	9,210,040	194,986	37	56
1920.	653,764	549,244	84	21,063,120	648,400	155	106
1921.	1,819,978	1,554,985	86	44,834,080	1,770,658	810	954
1922.	1,629,260	1,537,927	94	43,988,920	1,727,265	281	479
1923.	1,644,457	1,590,637	96	67,875,840	1,809,028	176	279
1924.	1,590,425	1,522,763	95	60,001,360	1,853,251	154	353
1925.	2,160,022	2,076,764	96	¹ 9,300,520	2,501,555	174	586
1926.	2,405,059	2,256,137	94	¹ 14,145,640	2,547,992	155	707
1927.	2,482,865	2,329,553	95	¹ 22,355,000	2,553,006	140	881
Total.	14,570,663	13,594,085	93	298,517,760	15,657,530	2,088	4,406

¹ Only mail with postage prepaid at the higher or special air mail rate was carried in 1925, 1926, and 1927.

Authority: U. S. Department of Commerce, Aeronautics Branch

As a result of legislation providing for the contracting with private operators for the carriage of mail by air within the United States, at a maximum rate of \$3 per pound (Kelly Act, Sec. 4, Air Mail Act of February 2, 1925), there rapidly developed a great contract air mail system, the nucleus of a rapidly growing general air transport net.

On January 1, 1926, there was in daily operation by the Post Office Department, both ways, the transcontinental mail route between San Francisco and New York, with an additional two-way night service between Chicago and New York; and the two foreign contract routes out of Seattle and New Orleans.

At various dates in 1926, beginning February 15, nine new domestic air mail contract routes were put in operation the first half of the year. Other routes were added during the second half, and the Post Office Department advertised the transcontinental and New York-Chicago overnight service for private operation.

At the end of the 1926 calendar year, 18 routes had been operated for mail or passengers, or both, and freight; 14

were contract air mail, 1 Government operated (transcontinental, including Chicago-New York additional service overnight), and 3 passenger routes. There were 55 station stops on the 1926 routes. Over \$5,000,000 was invested in the contract airway system by the air mail contractors this first year, and the sum was rapidly increased as new routes and new equipment were added.

On July 1, 1927, there were 15 mail airways in operation or under contract, 9 more advertised, and 3 non-mail routes. On December 31, 22 routes were operating, of which 18 were contract mail and 4 passenger or express lines. Seven more mail routes had been contracted for operation in the spring of 1928 and others were proposed. There are 80 station stops on these 29 routes which serve directly trading areas with more than 65,000,000 population. The daily distance flown on these 29 routes is more than 25,000 miles—or once around the world at the equator. In the spring of 1928 still other routes were added.

“At the end of 1928,” says “Aircraft Year Book, 1929,” “22 companies were operating 33 air mail lines under contract with the Post Office Department. Four new lines were placed in operation early in 1929. Mail planes were flying a total average of 27,848 miles every 24 hours.

“A number of the mail contractors were also carrying passengers or express, or both. Nine others having no mail contracts in 1928 had confined their scheduled flying to passengers or express. Without exception all the air lines were in process of expansion.

“Several companies had been either merged or absorbed during the year. Others had been reorganized with vastly increased capitalization to permit extension of their service. And new ventures in air transport were under way, the promoters having been attracted by the amazing developments in that field during the last twelve months.

“In 1926 there had been only 19 operators, the majority of them small individual enterprises. In 1927 the number had grown to 24, and the smaller operators were maturing into fairly well organized air line companies, while the larger organizations were beginning to show profits with a steady increase in traffic. In 1928 the air lines, with an aggregate

of 294 single and multi-engine transports in service, flew a total of 10,472,024 miles, against 5,242,839 miles in 1927.

“ That doubled mileage was accompanied by a threefold increase in air mail poundage and more than four times the number of passengers on regularly scheduled service. In 1927 the air lines of the United States carried 1,222,843 pounds of mail. In 1928 they carried 3,632,059 pounds. In 1927, 12,594 passengers were flown from one place to another on scheduled, regularly operated service. In 1928 they numbered 52,934.

“ Reports from all the operators having contracts with the American Railway Express indicate a healthy growth in business during the year; and yet the volume of business reported for 1928 remained approximately the same as that for the preceding twelve months, about 2,000 tons. That is explained by the fact that the majority of operators did not begin to carry express until late in the year, while in 1927 most of the air express was parcel freight carried for business houses and corporations which in 1928 acquired their own private machines for that purpose.

“ Just as reduction of air mail postage on August 1—from 10 cents to 5 cents for the first ounce—had the immediate effect of filling mail planes with capacity loads, so were many factors calculated to increase the volume of express.

“ Late in the year feeder lines were being developed to connect with the long haul systems. Regularity of service was constantly attracting public attention. Lack of accidents on the air transport routes was convincing the shipper that his valuable parcels might be safely flown. With the exception of the Ford Motor Company, which had operated its own flying express service for several years, practically all the parcel freight was flown during the last quarter of 1928. That promised rapid development during the ensuing months.

“ Evidence that the operators were no longer conducting an experiment in a new kind of transportation came at intervals throughout 1928, with one line after another expanding its service, placing new machines on its routes and seeking additional patronage. New passenger lines either launched or extended to other cities in 1928 numbered 23, and added 6,451 miles. Additional mail routes, either new or extended during the year, numbered 16 with 5,928 miles. Nine express lines were started, with a total of 2,151 additional miles for the year.”

New routes have been opened to include connections with Mexico, Canada, the Panama Canal Zone, Porto Rico, and South America.

AIRCRAFT PRODUCTION

The establishments engaged primarily in the manufacture of aircraft in 1927 built 1,857 airplanes, valued at \$12,024,085, and 105 seaplanes and amphibians, valued at \$2,226,520.

AIRCRAFT STATISTICS FOR THE UNITED STATES

Item	1927	1926	1925
Number of establishments reporting . . .	61	¹ 59	44
Wage earners (average number) ²	4,316	(³)	2,701
Wages ⁴	\$6,701,967	(³)	\$4,222,151
Cost of materials, including shop supplies, fuel, and purchased power ⁴	\$7,373,672	(³)	\$2,869,967
Cost of materials, including shop supplies	\$7,205,165	(³)	(⁵)
Cost of fuel and purchased power	\$168,507	(³)	(⁵)
Products, total value ⁴	\$20,783,733	¹ \$17,694,905	\$12,524,719
Airplanes—			
Number	⁶ 1,857	⁷ 1,125	711
Value	\$12,024,085	\$7,448,679	\$5,908,335
Seaplanes and amphibians— ⁸			
Number	105	61	78
Value	\$2,226,520	\$1,422,348	\$765,324
Value of aircraft under construction	(³)	\$2,377,769	\$1,428,447
Parts and engines made for sale, value	\$4,702,628	¹ \$6,054,973	\$3,544,423
All other products, including repairs and experimental work	\$1,830,500	¹ \$391,136	\$878,190
Value added by manufacture ⁹	\$13,410,061	(³)	\$9,654,752
Primary horsepower ¹⁰	5,813	(³)	3,735

¹ These figures differ from those originally published for 1926 because of the exclusion here and the inclusion in the 1926 report of data for 8 establishments not canvassed at the biennial censuses.

² Not including salaried employees.

³ No data.

⁴ The amount of manufacturers' profits can not be calculated from the census figures for the reason that no data are collected in regard to a number of items of expense, such as interest on investment, rent, depreciation, taxes, insurance, and advertising.

⁵ Not reported separately.

⁶ Includes 100 rebuilt and reassembled airplanes and 37 without engines.

⁷ Includes 171 rebuilt and reassembled airplanes.

⁸ Includes 45 amphibians in 1927 and 54 in 1926.

⁹ Value of products less cost of materials.

¹⁰ Factory horsepower, not horsepower of aircraft manufactured.

Authority: U. S. Bureau of Census.

The production in 1926 was 1,125 airplanes, valued at \$7,448,679, and 61 seaplanes and amphibians, valued at \$1,422,348. The combined production of all classes of heavier-than-air craft (airplanes, seaplanes, and amphibians) increased from 1,186, valued at \$8,871,027, in 1926 to 1,962, valued at \$14,250,605, in 1927, the rates of increase being 65.4 per cent for number and 60.6 per cent for value. A similar comparison for 1925 and 1927, based on a production of 789 aircraft, valued at \$6,673,659, in 1925, shows increases of 148.7 per cent in number and 113.5 per cent in value.

UTILIZATION OF OIL FOR HEAT

GROWTH OF OIL HEAT IN HOMES

During the past five years, the use of oil fuel as a means of producing heat for the household has come into its own. Strikingly parallel to the motor car in its bearing on the comfort and convenience of mankind, the domestic oil burner is taking its place with the automobile, and with the radio and electric refrigerator. Probably no other consuming agency of petroleum at this time more completely illustrates the modern tendency of human wants and desires, if the automobile be excepted.

Gains in productivity which, joined with a corresponding increase in consuming power, have "demonstrated on a grand scale the expansibility of human wants and desires," struck the President's Committee on Recent Economic Changes * as the most notable economic trend of the times. It is "this almost insatiable appetite for goods and services, this abounding production of all things which almost any man can want, which is so striking a characteristic of the period covered by the survey (1922-29)," says the committee.

Citing the electrical appliance industry, the committee finds that of the millions of wired homes "less than one-third of them had washing machines; slightly over one-third, vacuum cleaners; less than 5 per cent had electrical refrigerators." In spite of the millions of radio sets, "about 70 per cent of American homes are still without the radio."

"We seem only to have touched the fringe of our potentialities," says the committee.

The Oil Heating Institute estimates that on January 1, 1929, 422,700 domestic oil burners were supplying heat to homes in this country.

* Complete report published by McGraw-Hill Book Co., New York.

The potential market for oil heating is not limited to existing homes still burning coal, but includes an unlimited field in new construction. As indicative of this field, according to a survey made by *Building Age* and *National Builder*, the 1928 building program called for the construction of the following types of buildings for which oil heating was desirable:

Building type	Total U. S.	In 294 cities over 25,000 population
Multi-family apartments.....	26,520	14,200
Hotels.....	490	290
Public garages.....	8,056	4,850
Office buildings.....	2,915	1,600
Public buildings.....	474	295
Factories and workshops.....	8,070	4,920
Amusement buildings, theatres, etc.....	1,545	955
Hospitals, institutions, schools and libraries.....	2,625	1,230
Total.....	50,695	28,340

An investigation conducted by a special sub-committee of the National Electric Light Association, with the cooperation of the American Petroleum Institute, American Oil Burner Association, Oil Heating Institute, American Society of Mechanical Engineers, Underwriters' Laboratories, National Fire Protection Association, and a number of individual oil, oil burner, and electric light and power companies,* resulted in the conclusion that automatic heating of private homes, and public and commercial buildings, by oil burners electrically controlled, afforded a new field for public utility companies.

Electric current, the report points out, cannot be stored. It must be used at the moment of manufacture. Power plants can be operated more economically when the demand for current is spread more evenly over the 24 hours of the day. The peak load of the oil burner comes during the hours of daylight, when there is a sharp drop in the requirements for

* Publication No. 289-8, National Electric Light Association.

illumination. The seasonal peak comes in the winter, and thus balances the seasonal peak of the electric refrigerator, which comes in the summer. "The total electric load per season per oil burner compares favorably with the refrigerator load, and is deserving of being developed by public utilities," says the report.

OIL HEATING BEGAN ON WEST COAST

Being without commercial deposits of coal, early industries in California depended upon coal shipped from Australia, British Columbia, and the State of Washington, while experiments were being carried on with the use of oil as fuel. Even as early as 1883, oil was burned as a fuel on the Pacific Coast in heating some of the larger hotels and office buildings. Through these early experiments, the problems of burning and storing were met successfully, and oil was being burned for various purposes when the Kern County discoveries in 1899 made available in California the additional supplies necessary for increased use.

In the North Central States oil was burned as a fuel for a number of purposes, including the heating of buildings, prior to 1888, and also was used at the World's Columbian Exposition in Chicago in 1892 and 1893. The burning of oil as a fuel in this area undoubtedly was stimulated through the marketing of the fuel oil which was produced by the large refineries located on the Great Lakes. As the technical program of these refineries was altered to meet, through cracking, the increased demands for gasoline, the proportional output of fuel oil was decreased, and the markets which had been developed were then supplied by the shipment of fuel oil in tank cars from the refineries in the Mid-Continent area.

The development of fuel oil markets in the North Atlantic States, including New England, is of more recent date than in the two other principal burning regions. The presence of large refineries in this area, coupled with the ease with which oil may be transported by tanker to shore communi-

ties, assured this region of an adequate oil supply. The cities of Boston and Providence were the first communities in this area to adopt oil burning. A few large residences in these two cities burned oil prior to the war, but the installations were exceptional in that 14 to 16 gravity oil was burned and the furnaces were manually operated by the caretaker. New York was relatively slow in taking up the use of oil fuel, but after regulations making it possible to install plants were adopted about seven years ago, conversions from coal to oil went ahead with great rapidity. The nationally known Singer Building was first to adopt oil. In Boston one of the first plants to change over from coal to oil was the Harvard Medical School power plant, which furnishes heat, light, power, and refrigeration for a group of 34 hospital and college buildings. In Providence, R. I., virtually every building of prominence is burning oil. The real growth in oil burning in this area began about 1920.

IMPROVEMENTS IN BURNERS

In 1912, oil burners were installed by the U. S. government at For Baker, Calif., for heating and cooking. The results were very satisfactory, and considerable interest was aroused. This resulted in the development of improved types of natural draft vaporizing burners, which were being installed in various parts of the Middle West where oil was available.

In 1918 there were several engineers who had been working on burners suitable for use in steam automobiles. This led to the development of automatic controls, and the idea of using them for domestic heating was quickly born. While the mechanical draft burner was quickly recognized as a superior type of burner, the natural draft vaporizing burners had the advantages of price and a decided sales impetus. This accounts for the fact that there were in operation on January 1, 1921, 5,000 mechanical draft burners and 7,500 natural draft burners.

Natural draft burners maintained their lead in sales and number of installations until 1925. In 1923 and 1924 many of these burners were installed, sales being influenced no doubt by the unsatisfactory prospects for coal due to strikes; but their general unsatisfactory performance led to many being discarded in favor of mechanical draft burners or return to coal for fuel. This condition caused the curve showing the number of burners in operation to be flattened. The curve showing the number of mechanical draft burners in operation is smooth and steady, showing a very satisfactory rate of increase, while the natural draft burner has practically ceased to be a factor in the industry.

Municipal and state regulations throughout the United States governing the installation of oil burning equipment are increasingly satisfactory. The rules of the National Fire Protection Association (the rule making body for the National Board of Fire Underwriters) have been gradually modified, doing away with unreasonable requirements. The same is true of other agencies, including the fire marshals of municipalities. Only recently the Board of Standards and Appeals of the City of New York further modified and liberalized its fuel oil regulations.

STANDARD SPECIFICATIONS

Because of the fact that gravity does not provide a satisfactory classification for fuel oils, the American Oil Burner Association for three years made a study of the various characteristics of oil and, with the data collected, adopted a set of specifications covering these grades of fuel oil that are in general use today.

In January 1929, the Commercial Standards Unit of the U. S. Department of Commerce called an industrial conference for the purpose of establishing these specifications as commercial standards. With the exception of a few minor changes, they were adopted by the conference, and have been presented to the industry for acceptance.

TYPES OF HEATING

With the recent publication of the United States Bureau of Mines National Survey of Fuel Oil Distribution, which was made in cooperation with the American Petroleum Institute, there is available for the first time authentic fundamental data for estimating the number of domestic and commercial oil burners in use in the past and at the present time.

The term "domestic oil heating" refers to the application of oil burners in connection with central heating plants of homes, and includes small apartment buildings. The term "commercial oil heating" is used to classify application of burners for the heating of large apartments, office buildings, theatres, schools and similar buildings. This term should not be confused with "industrial oil burning," which is used to classify applications for developing steam for industrial power and also the application of burners for industrial processes, such as heat treating, drying ovens, etc.

These figures do not include the so-called stove burners, which are used in cook stoves, base burners and similar devices. There are a great number of these in use, which in the aggregate consume a quantity of kerosene and the lighter distillate furnace oils. These devices, however, cannot be considered as in the same classification with domestic oil burners for central heating plants.

DOMESTIC OIL HEATING

With the figures in the survey for the years 1923 to 1927 as a basis, the number of barrels of oil used each year from 1921 to 1928, for both mechanical or forced draft and natural draft, or non-mechanical burners, is estimated by the Oil Heating Institute. These figures are also broken down into two fuel classifications of light distillate furnace oil, approximately 38 degrees Baumé, and the heavy distillate furnace, or gas oil, approximately 28-36 degrees Baumé. The total consumption during the 1928-29 heating season is estimated at 17,000,000 barrels, against 2,820,000 barrels five years previously.

ESTIMATED OIL CONSUMPTION FOR DOMESTIC OIL HEATING
BASED ON BUREAU OF MINES 1927 SURVEY FIGURES FOR 1923-1927

Average Consumption for Mechanical Draft Burners, 60 Barrels per Year
Average Consumption for Natural Draft Burners, 40 Barrels per Year

Year	Mechanical draft Barrels	Natural draft Barrels	Total Barrels	Light furnace oil Barrels	Heavy furnace or gas oil Barrels
1921-22	300,000	300,000	600,000	500,000	100,000
1922-23	540,000	500,000	1,040,000	640,000	400,000
1923-24	1,410,000	1,410,000	2,820,000	2,260,000	560,000
1924-25	2,840,000	2,180,000	5,020,000	3,855,000	1,165,000
1925-26	4,700,000	4,130,000	8,830,000	6,860,000	1,970,000
1926-27	6,820,000	2,260,000	9,080,000	6,170,000	2,910,000
1927-28	10,600,000	1,780,000	12,380,000	6,000,000	6,380,000
1928-29	14,380,000	2,620,000	17,000,000	7,650,000	9,350,000

Authority: Oil Heating Institute

The number of burners operating on January 1, 1929 is estimated at 422,700, comprising 331,500 mechanical draft burners and 91,200 natural draft burners. On January 1, 1921, there were only 12,500 burners in operation in this country.

NUMBER OF BURNERS OPERATING *

	Mechanical draft	Natural draft	Total
January 1, 1921	5,000	7,500	12,500
January 1, 1922	9,000	12,500	21,500
January 1, 1923	23,500	35,300	58,800
January 1, 1924	47,300	54,500	101,800
January 1, 1925	78,500	103,000	181,800
January 1, 1926	113,900	56,500	169,400
January 1, 1927	177,000	44,500	221,500
January 1, 1928	239,000	65,200	304,200
January 1, 1929	331,500	91,200	422,700

* Estimated from the oil figures by assuming an annual consumption of 60 barrels for mechanical draft burners and 40 barrels for natural draft burners.

Authority: Oil Heating Institute.

COMMERCIAL OIL HEATING

There is less information concerning oil used for commercial oil heating, figures being available only for 1926 and 1927. According to the United States Bureau of Mines, there was a total of 27,800 commercial installations in operation during the heating year 1926-27, which consumed a total amount of 13,875,000 barrels of fuel oil. During the heating year 1927-28, there was a total of 30,300 installations which consumed 15,145,000 barrels of fuel oil. By projecting this curve back to the year 1925-26, a total number of installations of 24,000 is indicated with a fuel oil consumption of 12,000,000 barrels. By projecting the same curve forward, there is indicated for the heating year 1928-29, 33,500 installations with an estimated fuel oil consumption of 16,750,000 barrels. It is estimated that there is an average of $1\frac{1}{2}$ to 2 burners per installation, and these estimates on the consumption of fuel oil are based on an average of 500 barrels per annum per installation.

ESTIMATED OIL CONSUMPTION FOR COMMERCIAL HEATING

BASED ON BUREAU OF MINES 1927 SURVEY

Average Consumption for Commercial Installations, 500 Barrels per Year

Year	No. of installations	Total fuel oil Barrels
1925-26.....	24,000	12,000,000
1926-27.....	27,800	13,875,000
1927-28.....	30,300	15,145,000
1928-29.....	33,550	16,750,000

Authority: Oil Heating Institute

INDUSTRIAL OIL BURNING

There is scarcely an important industry that is not a potential user of oil for fuel in connection with process work requiring heat. At the present time considerable of this process work requires the use of lighter oils. Some of the

more important industries using and investigating oil heat for this purpose are the following: the automotive industry, in heat treating, forging, and oven drying operations; cement industry, for firing kilns; ceramic field, for heating ovens; the glass industry, for application ranging from the melting of the raw material to the annealing of the finished product; the brass foundries, rubber factories, paper and pulp mills. The iron and steel industry, already a large user of oil, has many applications in heat treating and process work.

Oil has been used as a fuel in the heating of buildings in the United States for nearly 50 years, but its widespread utilization and its application to domestic heating are distinct developments of the latter half of the post-war period. On the Pacific Coast and in portions of the Middle West, oil has been used as a fuel for several decades, but along the Atlantic Coast, and particularly in the cities from Portland, Me., to Washington, D. C., the most rapid strides have been made only within the past five or six years.

The first installations were made chiefly in existing boiler plants where coal had previously been burned. The experience thus gained established the possibilities of oil burning, and it has been given careful consideration by architects and builders in planning new structures. During the war period, building programs were suspended or postponed in order that material and labor might be diverted to strategically more important purposes. When the United States had recovered from the post-war depression of 1921, a national enthusiasm for building concentrated within a few years all of the construction which might ordinarily have been spread over a number of the preceding years.

During the period of suspended building, crude oil production in the United States increased from 335,000,000 barrels in 1917 to 732,000,000 barrels in 1923, with the result that an ample supply of oil was available coincident with the renewal of building activity. The inherent qualities of oil as fuel in urban heating, coupled with the development

of improved burners and definite sales' stimulation by oil producers and burner manufacturers resulted in a widespread adoption of oil as a fuel for commercial and domestic heating. Oil burning has been adopted in boiler plants of every type and size, from that of the central station, factory, office building, hotel, apartment house, hospital, theatre and school down to the smaller plants such as are used in the private home.

The following table shows the deliveries of gas oil and fuel oil for commercial and domestic heating during 1926 and 1927 by districts. These figures do not include the furnace oils and lighter distillates which were delivered for domestic heating and which it is estimated totalled approximately 6,000,000 barrels during 1926 and 1927.

GAS OIL AND FUEL OIL DELIVERIES FOR HEATING OF BUILDINGS
(Barrels of 42 Gallons)

District	Commercial heating		Domestic heating	
	1927	1926	1927	1926
Pacific Coast States.....	4,326,539	3,919,275	83,635	40,163
Rocky Mountain States.....	44,413	14,319	25,509	12,791
North Central States.....	2,063,976	1,348,270	2,941,748	1,168,538
South Central States.....	1,177,859	1,929,682	1,020,817	357,592
New England States.....	2,932,259	2,838,387	669,567	312,138
Middle Atlantic States.....	4,501,257	3,711,930	1,599,643	1,011,083
South Atlantic States.....	96,942	112,318	36,560	3,096
Total.....	15,143,245	13,874,181	6,377,479	2,905,401

Authority: U. S. Bureau of Mines.

Every district showed an increase in deliveries for commercial and domestic heating during 1927 over the previous year, with the exception of the South Central and South Atlantic States. In the first group the decrease is accounted for by the increased use of natural gas. The present tendency toward the use of heavier grades of oil for domestic heating, as well as the increasing number of installations, is shown by the increase in deliveries of light and heavy fuel oil for domestic heating. Deliveries for commercial heating continued to show a normal increase.

The preceding table shows deliveries of the light and heavy fuel oil included in the Bureau of Mines survey, without including the light furnace oils and distillates sold for domestic heating. The following table combines these deliveries with an allocation of the estimated quantity of lighter oils marketed, and presents a summary showing the total consumption of oil for the heating of buildings in the United States during 1926 and 1927:

OIL CONSUMED FOR HEATING OF BUILDINGS

Region	1927	1926
	<i>Barrels</i>	<i>Barrels</i>
Atlantic Coast States.....	11,836,000	9,989,000
Central United States.....	11,274,000	8,831,000
Pacific Coast States.....	4,410,000	3,960,000
Total.....	27,520,000	22,780,000

Authority: U. S. Bureau of Mines.

Of the oil used during 1927 for heating of buildings, 12,377,000 barrels were consumed in the heating of residences and 15,143,000 barrels in the heating of commercial structures. Although domestic oil heating is a development of the past few years, its rapid application is indicated by the following table showing annual estimated consumption:

OIL CONSUMPTION FOR DOMESTIC HEATING

Year	Barrels
1923 (Heating Season)	2,818,000
1924 (Heating Season)	5,021,000
1925 (Heating Season)	8,829,000
1926 (Calendar Year)	9,080,000
1927 (Calendar Year)	12,377,000

Authority: U. S. Bureau of Mines.

UTILIZATION OF FUEL OIL AND GAS OIL

HOW FUEL OIL AND GAS OIL ARE USED

The principal consuming agencies for fuel oil and gas oil are the merchant marine, the railroads, the oil producing and refining industry, gas and electric power plants, the iron and steel industry; and homes, apartments, etc., using oil for domestic and commercial heating. The U. S. Navy, now on an oil burning basis, is a large consumer of fuel oil; while the use of fuel oil in industry embraces almost every field employing heat and power. Smelters and mines consume as much as the U. S. Navy. Food industries, ceramic industries, cement and lumber plants, logging and lumbering, paper and wood pulp manufacturers; the textile, chem-

NATIONAL DISTRIBUTION OF GAS OIL AND FUEL OIL, 1926-1927
(In barrels of 42 gallons)

Uses	1927	1926
Railroads.....	70,094,416	72,217,652
Bunker oil, including tankers.....	88,215,028	79,287,605
Gas and electric power plants.....	29,774,772	33,651,513
Smelters and mines.....	6,831,275	8,951,817
Iron and steel products.....	17,196,778	16,102,458
Chemicals and allied industries *.....	2,189,949	.....
Automotive industries.....	1,686,605	1,603,393
Textiles and their products *.....	4,620,626	.....
Paper and wood pulp *.....	3,130,603	.....
Logging and lumbering.....	2,370,449	3,183,597
Cement and lime plants.....	5,051,051	5,586,144
Ceramic industries.....	3,270,036	3,216,850
Food industries.....	7,143,203	7,674,766
Other manufacturing *.....	11,352,558	23,017,235
Commercial heating.....	15,143,245	13,874,181
Domestic heating.....	6,377,479	2,905,401
U. S. Navy, transports, etc.....	6,505,869	6,541,638
Used as fuel by oil companies.....	43,452,584	48,701,023
Miscellaneous uses.....	9,353,488	7,514,599
	333,760,014	334,029,872

* Deliveries to chemical and allied industries, textiles and their products, and paper and wood pulp were included under "Other manufacturing" in the 1926 survey. Sugar refineries are included with "Food industries" in the 1927 survey.

Authority: U. S. Bureau of Mines.

DISTRIBUTION OF GAS OIL AND FUEL OIL, BY STATES, 1926-1927
(In barrels of 42 gallons)

States	1927	1926
Alabama.....	405,987	1,072,713
Arizona.....	2,680,687	3,697,676
Arkansas.....	2,210,142	1,802,026
California.....	89,844,872	86,615,334
Colorado.....	884,008	420,470
Connecticut.....	2,594,200	2,285,601
Delaware.....	632,587	884,014
District of Columbia.....	971,962	758,570
Florida.....	7,397,119	9,210,297
Georgia.....	1,349,465	1,504,206
Idaho.....	30,083	61,391
Illinois.....	11,430,491	8,992,051
Indiana.....	4,318,209	3,090,862
Iowa.....	662,590	666,153
Kansas.....	4,815,814	5,164,216
Kentucky.....	403,713	259,016
Louisiana.....	18,206,587	20,657,892
Maine.....	1,273,031	1,617,447
Maryland.....	5,113,530	5,291,471
Massachusetts.....	11,966,115	12,080,091
Michigan.....	2,982,062	2,398,041
Minnesota.....	1,514,400	979,585
Mississippi.....	334,915	413,757
Missouri.....	5,277,709	5,146,747
Montana.....	2,824,720	2,352,173
Nebraska.....	1,010,562	748,547
Nevada.....	815,351	587,372
New Hampshire.....	153,594	175,590
New Jersey.....	19,676,609	14,928,682
New Mexico.....	386,931	271,645
New York.....	34,324,041	35,951,626
North Carolina.....	214,626	321,741
North Dakota.....	25,070	40,182
Ohio.....	2,900,226	3,138,376
Oklahoma.....	8,846,551	8,704,423
Oregon.....	5,269,714	6,066,230
Pennsylvania.....	14,472,715	17,291,204
Rhode Island.....	4,654,374	4,567,337
South Carolina.....	980,034	1,284,195
South Dakota.....	106,046	121,909
Tennessee.....	485,019	367,703
Texas.....	44,500,450	47,999,196
Utah.....	429,494	376,494
Vermont.....	140,942	73,212
Virginia.....	1,508,343	1,516,369
Washington.....	8,183,611	7,358,520
West Virginia.....	394,144	415,806
Wisconsin.....	1,440,561	1,101,141
Wyoming.....	2,716,008	3,200,572
	333,760,014	334,029,872

Authority: U. S. Bureau of Mines.

ical, and automotive industries are some of those employing oil fuel for which statistics of consumption are available.

A survey of gas oil and fuel oil distribution in the United States during 1927 was made by the U. S. Bureau of Mines, in cooperation with the American Petroleum Institute; and the uses are shown in the table on page 193.

The Pacific Coast states, farthest removed from coal sources, lead in the regional consumption of fuel oil; and are followed by the South Central and Middle Atlantic states.

The North Central region, including mainly the states bordering the Great Lakes, showed the largest proportional increase in consumption in 1927, while the South Central and South Atlantic States showed decreases in requirements. A greater utilization of natural gas in Texas and Louisiana was mainly responsible for the decreased deliveries of fuel oil in the South Central States, while the decreased demand in the South Atlantic States was centered largely in Florida and was caused by a decrease in locomotive fuel consumption by the single oil burning railroad operating in that area and by the completion of certain dredging operations which had consumed relatively large quantities of fuel oil.

REGIONAL DISTRIBUTION OF DELIVERIES, 1926-1927

(In barrels of 42 U. S. gallons)

Region	1927		1926	
	Barrels	Per cent	Barrels	Per cent
Pacific Coast States.....	106,794,235	32.00	104,325,132	31.23
South Central States.....	84,598,155	25.34	90,960,970	27.23
Middle Atlantic States.....	75,191,444	22.53	75,105,567	22.48
North Central States.....	27,278,949	8.17	21,903,566	6.56
New England States.....	20,782,256	6.23	20,799,278	6.23
South Atlantic States.....	11,843,731	3.55	14,252,614	4.27
Rocky Mountain States.....	7,271,244	2.18	6,682,745	2.00
Total.....	333,760,014	100.00	334,029,872	100.00

Authority: U. S. Bureau of Mines.

OIL FOR VESSELS

The application of oil burning to marine transportation increased rapidly during the early part of the post-war decade. On June 30, 1920, the merchant marine of the world fitted to burn oil had a registered gross tonnage of 9,000,000 tons. Each succeeding year showed an increase in registration—particularly rapid until 1925. Since that date the gross tonnage of oil burning steamers has continued to increase (amounting to 23,314,000 tons, including motor vessel tonnage in 1928), but at a somewhat lower rate than in the earlier years of the period. (See “World Production and Consumption of Petroleum: World Oil Burners.”)

Registration of motor ships during the past five years, on the other hand, indicates a trend towards that type of marine transportation which is commensurate with the conversion of steamers to oil burning during the period 1914-1919. World motor ship registration has increased from 1,248,000 gross tons in 1923 to 4,592,000 gross tons in 1928.

OIL FOR RAILROADS

Southwestern and Pacific Coast railroads are the principal users of oil for locomotive fuel. Oil burning locomotives have been in operation since the early nineties.

The Diesel type of locomotive is now being extensively tried out by American railroads.

OIL FOR POWER PLANTS

The total quantity of gas oil and fuel oil delivered to gas and electric power plants in the United States during 1927 showed a decrease, according to the U. S. Bureau of Mines; and there was a decrease in the demand by gas manufacturers, attributed in part to changes in processes which substituted coke oven gas for water gas, by increased economy of steam generators, and by the purchase of still gas from petroleum refineries in substitution for the manufacture of artificial gas.

FUEL BURNED AT REFINERIES

A survey by the U. S. Bureau of Mines to determine the trend of fuel consumption at refineries in the United States, showed a decrease in the use of oil for fuel of over 5,000,000 barrels in 1927 as compared with 1926; a decrease in the use of coal of over 1,000,000 short tons; and increases in the use of natural gas, refinery gas, and petroleum coke.

The decrease in fuel oil consumption was approximately 2,000,000 barrels each in the Atlantic Coast, Texas, and Louisiana-Arkansas districts, with an increase of 1,000,000 barrels in the Indiana-Illinois district, or a net decrease of 5,000,000 barrels. The decrease in fuel oil consumption by refineries in the Texas and Louisiana-Arkansas areas was offset largely by increased consumption of natural gas and refinery gas, whereas the increased consumption in the Indiana-Illinois region was more than offset by the decrease in coal consumption.

The problem of fuel economy continued to occupy the attention of many refinery engineers, and largely through their efforts the fuel requirements per barrel of crude refined were less in 1927 than ever before. In order to arrive at this conclusion, the consumption of the various fuels was reduced to their B. t. u. equivalents * and gave a total of 584,000,000,000,000 B. t. u. used in 1927, as compared with 630,000,000,000,000 B. t. u. in 1926. There were 779,264,000 and 828,380,000 barrels of crude petroleum refined in the United States in 1926 and 1927, respectively; these amounts on division indicated a requirement per barrel of 809,000 B. t. u. in 1926 and 705,000 B. t. u. in 1927, a decrease of approximately 13 per cent.

* The following factors were used in this calculation:

Oil, 6,000,000 B. t. u. per barrel; coal, 26,000,000 B. t. u. per short ton; gas, 1,050 B. t. u. per cubic foot; coke 30,000,000 B. t. u. per short ton; 1 kilowatt hour, 3,415 B. t. u.

OIL FOR COMMERCIAL AND DOMESTIC HEATING

The 1927 demand for gas oil and fuel oil for commercial and domestic heating called for the delivery of 21,521,000 barrels, as compared with 16,780,000 barrels in 1926. Heating of office buildings, apartments, schools, hotels, hospitals, and other buildings required 15,143,000 barrels in 1927, as compared with 13,874,000 barrels in 1926; while 6,377,000 barrels were delivered to homes for domestic heating in 1927, as compared with 2,905,000 barrels in 1926. (See "Utilization of Oil for Heat.")

UTILIZATION OF DIESEL OIL

DEVELOPMENT OF DIESEL ENGINE

In no field of mechanical accomplishment has man's ingenuity been more strikingly demonstrated than in the comparatively recent development of the Diesel engine. Its problems are many and complex. During the age when the steam engine held complete sway as a prime mover, coal or even wood, burned under a boiler, liberated heat for the production of steam. By this system seldom more than 18 per cent, and often much less, of the total heat energy of the fuel became available to do mechanical work. There followed gasoline engines.

In 1898 came the Diesel, a prime mover which eliminated the boiler and burned its fuel directly in the engine cylinder. This engine was designed by Doctor Rudolf Diesel, a German scientist, to burn coal dust only, but difficulties were encountered and the efforts made to overcome them revealed the fact that liquid fuel could be burned much more easily. Subsequent development advanced along this line.

The first engines were ponderous affairs, but even they could transform from 25 to 34 per cent of the potential heat value of a fuel into actual work. The features of higher economy, great saving in space and the growing supply of cheap liquid fuel created a demand for the Diesel type of engine.

Progress, however, was slow. It was difficult to find metals which would withstand the intense heat produced. Operating temperatures are necessarily extremely high, as the Diesel design depends upon the great heat of high compression to ignite the charge of fuel rather than upon an electric spark.

The development of lubricants suitable for such high temperatures, as well as the correspondingly heavy pressures which accompanied them, presented a problem for the solution of which the oil companies early began to employ their best refining and engineering skill. The result is the specialized series of Diesel engine lubricants now in use on the high seas, on inland waters, and in stationary plants.

WAR AN IMPETUS TO DEVELOPMENT

The development of Diesel power for marine service received a great impetus from the wonderful records made by this type of engine in the submarines of the various navies during the World War, when their performance definitely established the reliability of this type of prime mover. Immediately after the war, various engineering companies all over the world took up the development of the Diesel, with the result that from the earlier engines weighing about three hundred pounds per horsepower and running at slow speeds, design has progressed to engines weighing less than three pounds per horsepower and turning at the rate of a thousand revolutions per minute.

To the use of Diesel power on land and sea is apparently soon to be added its employment in the air. It is said that more than one government is experimenting with Diesels in dirigibles, while the Packard Motor Company has developed a radial air-cooled Diesel weighing under three pounds per horsepower. An airplane has recently made successful flights with this motor.

DIESELS IN MARINE SERVICE

As evidence of the increasing favor with which Diesel power is regarded for marine work: In 1924 Diesel engine tonnage comprised 19½ per cent of the total world tonnage under construction. By 1928 it had risen to almost 50 per cent. (See "World Production and Consumption of Petroleum: Growth of Motor Ships.")

The sale of Diesel engines for land installation in the United States totalled 440,000 horsepower in 1928.

A striking example of the reliability of the Diesel engine and its ability to start and to take a heavy load almost instantly was given recently when the American vessel *Malolo*, while making her trial run off New York, was rammed by a ship of foreign registry. Almost immediately her engine room was flooded, and she was left without power to operate her pumps or even to make current for her wireless. She carried an auxiliary Diesel power plant in the superstructure of the ship, well above the water line. This unit was started from dead cold, and in a few minutes enabled the wireless operator to call for assistance, and also supplied light so that the crew could make emergency repairs in the engine room.

The *Leviathan*, Queen of the American merchant fleet, is provided with a twin set of Diesel-driven generators for emergency use. Many of the palatial new ocean greyhounds, under construction or recently commissioned, are Diesel powered. Diesel-engined passenger ships are advertised as vibrationless, because of the smoothness of the operation of their power units. The Italian motorship *Augustus*, of 32,500 gross tons, is the largest Diesel passenger ship afloat. She is propelled by Diesels totalling 28,000 horsepower.

The next great naval conflict, if one should unfortunately come, will surely see a much increased employment of Diesel power. The latest German cruiser, *Annihilator Ersatz Preussen*, apparently as formidable as its tremendous name, is said to be the last word in warship design and to be actually a challenge to the rest of the world in naval construction. Although well within the arbitrary conditions laid down by the Washington naval treaty, she is reported to be far superior to any other fighting craft afloat, and the secret of her power lies not so much in her heavy armor or her big guns as in her Diesel engines, which, owing to their light weight and economy of operation, make it possible for her to carry fuel for a ten-thousand-mile cruise at a speed of 20 knots, with a maximum speed of 26 knots.

INDUSTRIAL USE GROWING

On land the development of Diesel engines for central station work has progressed so that there are now many giant Diesel plants scattered all over the world. Among those of particular interest are the Panama Canal plant at Miraflores, comprising 12,375 brake horsepower in three engines; the 15,000-horsepower Diesel electric plant at Hamburg, Germany; the 20,000-horsepower Diesel electric central station at Shanghai, China, and many others. The Diesel is coming into increasing favor for pipe line pumping operations, also in locomotive switching service; and there is at least one Diesel-driven motor truck now in successful use.

So it is apparent that the Diesel has come to stay with us in the air, on land, on the sea, and under the sea.

UTILIZATION OF LUBRICATING OILS

PETROLEUM LUBRICANTS AND THE MACHINERY AGE

Petroleum lubricants have played an indispensable part in the mechanical development of the past three-quarters of a century.

In the memory of men now living, the only lubricants in use were those made from animal fats and from various vegetable substances. Machinery was crude, cumbersome, and slow, owing to the lack of lubricants that would give efficient lubrication to fast moving parts or that could be applied efficiently.

Practically every mechanical device used today not only employs petroleum lubricating oil in its operation, but its development was made possible only through the development of suitable lubricants. The modern world without petroleum lubricants is almost unimaginable.

To the average man, lubricating oil is merely a by-product of the manufacture of gasoline and kerosene, and he sees it simply as what is left of crude petroleum after the more volatile substances have been removed. Its major use is, he believes, if he has given the subject any thought at all, in the crankcases of automobiles.

In the beginning, it is true, lubricating oil was more or less a by-product of the manufacture of kerosene. The development of modern machinery through lubrication is the outgrowth of the thrifty thought that some use ought to be found for the substances which remained in the stills after the kerosene had been removed. Today some important refineries operate only for the purpose of producing lubricating oil. The gasoline and kerosene are listed among the by-products of these refineries.

Strictly speaking, the history of petroleum lubricants goes back long before Colonel Drake drilled his famous pioneer

well in the hills of Pennsylvania. Farmers who had access to springs of petroleum oil found that it was an inexpensive substitute for the crude animal fat axle grease. It was the practice in those days to smear the crude petroleum on the wagon bearings and replenish it as occasion—and necessity—suggested. Perhaps it was an unusually astute agriculturist who found that a thicker, more durable lubricant could be had by exposing the crude petroleum to the sun until the lighter products had evaporated.

In the excitement attending the discovery of a method for producing a superior burning oil which could be marketed at a cost far below anything that had been available, even this small use of petroleum as a lubricant was given little thought.

In the distillation of petroleum, one product only was desired, and that was kerosene. The lighter ends, now called gasoline, were too dangerous to include in the kerosene, and they were disposed of speedily. Hardly less a nuisance was the thick, somewhat gummy substance left in the stills when the refiner had extracted from the petroleum all of the kerosene which the crude methods of the late fifties and early sixties made possible.

FOUNDATION OF MODERN LUBRICATING OIL INDUSTRY

It remained for the owner of a small refinery some little distance away from the center of the oil excitement to see in the still residue the foundation for the modern lubricating oil industry. Upon his discovery, the entire structure of the present mechanical age has been built. Curiously enough, thrift—the kind of thrift which looks with disfavor upon any kind of waste—was the reason for his discovery.

This refiner, Hiram B. Everest, endeavored to make from the residue of the petroleum refined in his little plant at Rochester, N. Y., an oil which might be substituted for the animal, vegetable, and fish oils used in the currying of leather. He was successful, but found that someone had anticipated his discovery and had obtained legal protection for the invention.

Everest then thought that perhaps the residue might be treated in some way that would make it a suitable substitute for the tallow and animal fats used for cylinder lubrication. His experiments convinced him that he was on the right track, and he was soon able to offer mineral oil to the public as a steam cylinder lubricant.

Crude as were the early engines, and simple as were the lubrication problems they offered, the pioneer's road was not at all smooth. The public was slow to accept the new discovery. Energetic salesmanship made it possible to obtain trials for the new mineral lubricant, but the battle was not won with a few trials, although it would seem that the improved lubricants should have been received by industry with open arms. As a matter of fact, a big part of the job of the first lubricating oil organization was in devising systems of lubrication, by which petroleum lubrication might be adapted to the needs of the machinery then in operation and in persuading operators of engines that the new lubricant would not ruin their machinery.

However, these were but the growing pains of a new industry. It was not long before the superiority of petroleum lubricants to every other form of lubrication for practically every purpose was recognized in every civilized country.

At the beginning, petroleum lubrication was offered merely to meet the lubrication needs of the then existing machinery. This condition did not long exist.

LUBRICATING OIL OPENS WAY FOR MACHINE AGE

Designers of machinery discovered that petroleum lubrication was not merely more convenient and more economical than lubrication with chunks of animal fat, but that it made possible the solution of problems of machine design that had previously seemed impossible of solution. It was apparent that the new lubricant opened the way for a new era of mechanical development. Inventors and designers of mechanisms were not slow to avail themselves of the advantages of the new form of lubrication.

Machines capable of moving at higher speeds quickly became available. Machines capable of turning out greatly increased amounts of work were designed and put into operation. Smaller clearances between bearings, more economical means of utilizing power, devices in which advantage was taken of the new ability to put lubricants where they were needed in small quantities, were produced.

The machine age opened.

LUBRICANTS TO MEET VARIETY OF NEEDS

Each new machine offered a new problem to the refinery owner who had specialized in the production of lubricants. It was quickly found that the lubricant that was ideal for one machine was as useless in another as the old piece of tallow would be. It was necessary to develop, from crude oil, lubricants to meet each of these new needs.

With this discovery went the last vestige of the idea that lubricating oil was merely the residue from kerosene extraction. The development of lubricating oil, and the development of the art or science of applying lubrication correctly and efficiently, became professions.

Designers were building machines demanding lubricants of a wide range of characteristics. As the possibilities of lubrication became known, designers thought less and less about the problem of lubrication, confident that the petroleum lubricating industry would produce the lubricant that the operating characteristics of the machines demanded. In one machine, the oil had to be so thin as to flow most freely to the point where it was needed. Perhaps, at the same time, it had to resist the action of great heat. In another machine, it might have to be thick and heavy and yet capable of being forced into an extremely thin but tenacious film at the point of application.

The lubricating oil industry worked out each problem. It developed methods of treating crude oils to obtain the desired characteristics. It worked out methods of selecting various crude oils in order to obtain from each the benefit

of its peculiarities so that, under proper treatment, the completed stock might have one or more of the characteristics desired. It developed methods of blending stocks made from several crudes in order to obtain in the finished product the characteristics that no one crude could provide. It developed methods of refining to protect the crude oil from the harmful effects of too much heat.

It is no exaggeration to say that the oil on the market today has in it the results of three-quarters of a century of intensive experimentation.

LABORATORY OF ENTIRE INDUSTRIAL WORLD

It is a curious feature of the rise of the petroleum lubricating oil industry that at no time has the industry been able to depend entirely upon laboratory work for the development of lubricants. No yard stick has ever been made to measure the suitability of a lubricant for service. It is true that a certain device may demand oil of certain characteristics, but whether it will perform properly in the machine, and give the service it should give, is never known until it is tried out under actual conditions of service. The result is that the lubricating industry has had to keep close to the industries which use lubricants and to consider the entire industrial world its laboratory.

In the middle seventies the automobile was a dream of an inventor who found that it was impossible to keep his internal combustion engine in operation. He tried animal and vegetable oils and found that none of them was suitable. He was on the verge of discouragement when he heard of a petroleum product that possessed none of the disadvantages of animal or vegetable lubricants. He obtained some of the mineral oil, and solved at one stroke the problems of oil decomposition and offensive exhaust smoke that had threatened the success of his experiments.

The development of the electric generator and motor brought up new problems to be solved by petroleum lubricants. Slow as the speeds of the early models of these

devices were, the speeds were great enough to offer serious problems, not only to their designers but to the manufacturers of lubricants who were expected to provide means of lubricating them. The problem led to the development of a lubricant made from petroleum having characteristics entirely unlike any that had preceded it.

An example of the manner in which the petroleum lubricating industry has had to meet new demands created by the various industries of the world lies in the development of the electric transformers, without which it would scarcely be possible to transmit electricity over long distances. As transformers grew larger, their designers utilized petroleum lubricating oil as a cooling, insulating medium. It was found that the presence of minute quantities of water in lubricating oil limited the size to which these transformers could be built. Consequently, the petroleum industry developed new processes to provide for the electrical industry insulating oils having characteristics suited to this new use. An idea of the wide diversity of products made from petroleum oil is seen in the fact that insulating oils are shipped in containers marked with warnings against the use of the products as lubricants in machinery.

Steam turbines presented their own set of problems when the first of them was introduced in the early nineties. Their characteristics made it impossible to keep water and oil from getting together. Water, churned with the oil, formed a sludge which choked the pipes and interfered with lubrication. The problem was to develop an oil that would not sludge in the presence of water and which would readily separate.

The development of the Diesel engine offered another set of problems, and made necessary the development of oil with special characteristics needed for the efficient operation of these engines. The textile industry provided still another problem in the development of high speed spindles, with lubrication problems of their own. In fact, every industry has its story of the solution of some lubricating problem.

The early automobiles were crude affairs compared to the fast, comfortable, efficient and quiet vehicles of today; and those close to the industry have seen remarkable changes during the past decade in the lubrication problems of this industry. Lubricants in use in today's automobiles are asked to perform under conditions that were undreamed of a few years ago. It is to the credit of the industry that progress along this line has been so rapid, and at the same time that the modern motorist has to give very little thought to the lubrication of his car.

NEEDS OF AUTOMOBILE ARE TYPICAL

It is apparent that a wide variety of lubricants is necessary to meet the needs of modern industry. Not only does each industry present a need for lubricants especially designed for its requirements; but machines, designed to do the same work, differ in their details to such an extent that a lubricant suitable for one manufacturer's machine is unsuited for a somewhat similar machine made by another manufacturer.

The most familiar example of this is the automobile. To meet the needs of all automobiles on the road, one lubricating oil concern manufactures five or six different oils for crankcase use alone, and as many more different products for other parts of automobiles. The ideal oil for one car may well be considered absolutely unsuited for another. Steam turbines, alike in general principles and operating conditions, require several different oils in order to meet the design characteristics of the products of various manufacturers. For paper mill machinery, nearly a dozen different oils are necessary, each machine calling for the use of several different kinds.

To meet modern conditions, scores of different kinds of oil are necessary. To produce these oils, specialists in lubrication must study not only the crude oil from which they are to be made, but must develop treatments and processes to bring out the various desired qualities and characteristics. They must also have engineering knowledge of the uses to which the oils are to be put. The industry must

constantly look ahead in order to anticipate the demands of engine builders.

AVERAGE CITIZEN DEPENDENT ON OIL LUBRICATION

It has been said that the average citizen has a very small conception of the extent to which he is dependent upon lubrication. His clothes are machine woven and machine sewed only because lubricants have made possible the development of high speed machinery for the work. He has running water in his home only because means have been found to lubricate pumping machinery. Electricity is his at the turn of the switch because lubricants have been developed for the high speed machinery necessary for its production, and because other petroleum products have made possible the transmission of the current over long distances. His automobile could run only a few feet without lubrication—and lubrication of a highly specialized kind. Railroad trains could not operate at any speed comparable with modern conditions had not suitable lubricants been devised for the fast moving parts. The safety devices which make modern railroad travel safe would be inoperative without lubrication.

Without lubrication, and particularly modern petroleum lubrication, elevators could not run. Electric signs would be unable to flash their advertising messages. Printing presses could not run, and linotype machines could no longer make type slugs. Practically the only kind of work that could be accomplished in any industry would be that which could be performed by manual operation of the most simple devices.

Nor is the petroleum lubricating industry looking at today alone. All over the country, wherever there is an organization concerned with the manufacture of lubricants on a large scale, scientists are working in well-equipped laboratories and conducting tests in the field. They are working not only to provide the best of lubrication for the machines of today, but to make the progress that is necessary today in order to meet the lubrication needs of tomorrow.

UTILIZATION OF ASPHALT AND ASPHALTIC PRODUCTS

Asphalt is the semi-solid, black sticky residue, produced by the partial distillation of certain petroleums. By a process of natural evaporation asphalt has been produced likewise in certain deposits, at or below the earth's surface, which products are most commonly known as lake asphalt and rock asphalt. Of all the asphalt produced and consumed in the United States, however, the greatest bulk is refined directly from petroleum, and is known as petroleum asphalt.

In addition to the semi-solid and solid asphalts, a variety of fluid products containing a relatively high percentage of asphalt are obtained by distilling petroleum. To this class belong the residual road oils and fluxes. These products have not been distilled sufficiently to reduce the residue to the consistency of asphalt. Other fluid products, produced by combining the semi-solid or solid asphalts with such distillates as gasoline or kerosene, are known as cut-back asphalts and have the property of hardening with a rapidity that is dependent upon the volatility and quantity of the distillate used in their preparation.

Asphalt is a highly cementitious, plastic material, and is used principally as a binder or cementing medium. It is waterproof and resistant to the attack of most acids, and these properties, together with its cementitiousness, make it of great value for numerous and widely varied industrial purposes.

During 1927 nearly 4,000,000 tons of asphalt and asphaltic products were produced from petroleum in the United States. About 2,200,000 tons, or approximately 55 per cent, was consumed in the construction and surface treatment of roads and pavements. About 33 per cent was used in the manufacture of roofing and for waterproofing purposes, and the remaining 12 per cent was used in the manufacture of a

**ASPHALT AND ASPHALTIC MATERIAL MANUFACTURED IN THE UNITED STATES
FROM PETROLEUM AND SOLD AT REFINERIES, 1926 AND 1927, BY VARIETIES
(Value f. o. b. refinery)**

	From domestic petroleum		From foreign petroleum		Total	
	Short tons	Value	Short tons	Value	Short tons	Value
1926						
Solid and semisolid products of less than 200 penetration: ¹						
Asphalt—						
Paving.....	471,000	\$6,026,920	868,320	\$12,928,530	1,339,320	\$18,955,450
Roofing and waterproofing...	297,020	3,738,250	484,600	6,898,790	781,620	10,637,040
Mineral rubber.....	25,570	544,380	16,920	250,850	42,490	795,230
Other solid and semisolid products.....	101,720	1,263,100	137,030	2,049,330	238,750	3,312,430
	895,310	11,572,650	1,506,870	22,127,500	2,402,180	33,700,150
Semisolid and liquid products of more than 200 penetration: ¹						
Flux—						
Paving.....	14,340	175,460	112,470	1,422,950	126,810	1,598,410
Roofing and waterproofing...	55,960	684,290	285,450	3,542,770	341,410	4,227,060
Other.....	1,930	34,450	168,410	1,983,840	170,340	2,018,290
Other liquid products.....	59,150	499,680	24,530	323,290	83,680	822,970
	131,380	1,393,880	590,860	7,272,850	722,240	8,666,730
Road oil.....	218,470	2,486,410	115,580	1,698,110	334,050	4,184,520
Grand total.....	1,245,160	15,452,940	2,213,310	31,098,460	*3,458,470	46,551,400
1927						
Solid and semisolid products of less than 200 penetration: ¹						
Asphalt—						
Paving.....	556,280	8,199,100	1,095,910	16,978,260	1,652,190	25,177,360
Roofing and waterproofing...	457,460	5,471,350	561,190	8,407,880	1,018,650	13,879,230
Mineral rubber.....	4,840	86,410	16,070	244,520	20,910	330,930
Other solid and semisolid products.....	78,180	928,810	91,590	1,372,530	169,770	2,301,340
	1,096,760	14,685,670	1,764,760	27,003,190	2,861,520	41,688,860
Semisolid and liquid products of more than 200 penetration: ¹						
Flux—						
Paving.....	22,470	311,810	207,330	2,757,010	229,800	3,068,820
Roofing and waterproofing...	100,350	1,151,680	183,560	2,398,560	283,910	3,550,240
Other.....	860	14,420	190,350	2,461,770	191,210	2,476,190
Other liquid products.....	62,140	506,970	25,760	370,490	87,900	877,460
	185,820	1,984,880	607,000	7,987,830	792,820	9,972,710
Road oil.....	242,840	2,348,600	54,270	780,920	297,110	3,129,520
Grand total.....	1,525,420	19,019,150	2,426,030	35,771,940	3,951,450	54,791,090

¹ Definitions:

Paving asphalt—Refined native asphalt and asphaltic cement, fluxed and unfluxed, produced for direct use in the construction of sheet asphalt, asphaltic concrete, asphalt macadam, and asphalt block pavements, and also for use as joint filler in brick, block, and monolithic pavements.

Roofing and waterproofing asphalt—Asphalt and asphaltic cement used in saturating, coating, and cementing felt or other fabric and in the manufacture of asphalt shingles.

Mineral rubber—Asphalt and asphaltic cement used by the rubber industry.

Other solid and semisolid products—Asphalt and asphaltic cement used as dips and in the manufacture of insulating material, acid-resisting compounds, putty, mastic, and briquets and not included in the preceding definitions.

Flux—Liquid asphaltic material used in softening native asphalt or solid petroleum asphalt for paving, roofing, waterproofing, and other purposes.

Other liquid products—Petroleum asphalt used in the manufacture of saturant, paint, varnish, or other coating, exclusive of fuel oil, and not included in the preceding definitions.

Road oil—Residual asphaltic oil used for surface treatment.

Authority: U. S. Bureau of Mines.

great variety of products such as wall-board, flooring, floor coverings, sheathing, moisture-proof wrapping paper, paints, varnishes, enamels, Japans, anti-acid coatings, pipe-dips, sealing compounds, insulating products, emulsions, molding compositions, and in the compounding of rubber products.

From 1918 to 1927 the annual production of petroleum asphalt in the United States increased from 1,202,420 tons to 3,951,450 tons. This was due largely to the tremendous expansion in city asphalt pavement and rural highway asphalt construction which, during the same period, increased from 53,000,000 square yards per year to about 144,000,000 square yards, equivalent to 13,600 miles of pavement 18 feet in width.

ASPHALT PAVEMENTS LAID IN UNITED STATES

Year	Square yards	Year	Square yards
1922.....	90,000,000	1925.....	130,000,000
1923.....	108,000,000	1926.....	133,000,000
1924.....	125,000,000	1927.....	144,000,000

Authority: Asphalt Association.

During recent years the use of asphaltic road oils and cut-back asphalts in the treatment and construction of low cost and secondary roads has increased very rapidly, and it seems probable that future developments along this line shortly will more than double the present consumption of asphalt. Asphalt is considered of particular value in building landing strips, parking spaces, runways and taxiways at the modern airports which are now being constructed in all parts of the country. The asphalt pavement or roadway, being flexible as well as waterproof, is particularly well adapted to resurfacing and salvaging highways that are now obsolete, but which are sufficiently substantial to serve as foundations. In such cases the asphalt is utilized merely by laying a relatively thin asphaltic wearing-course over the old roadway.

The asphalt roofing industry has grown to enormous proportions in recent years, since this type of relatively low

cost roofing has become exceedingly popular because of its durability and pleasing appearance. Several types of roofing have been devised, including smooth-roll roofing, slate-roll roofing, strip shingles and individual shingles. The present annual production of the various types of asphalt roofing is sufficient to cover more than 363,000,000 square yards of roof surface.

American refined asphalt is finding increasing favor in foreign countries. During 1927, some 385,000 tons were exported from the United States, of which Europe consumed 225,148 and Asia 63,797 tons.

HEAVY OILS FOR FARM ROADS

A most extensive future use of asphaltic materials is in the treatment and construction of low cost secondary roads throughout the United States. A summary of a report on this subject by E. W. James, Chief, Division of Design, U. S. Bureau of Public Roads, follows:

Recent studies made by the Highway Research Board, the American Road Builders' Association, the Bureau of Public Roads and the states of Illinois, Wisconsin, Minnesota, Oregon, and California clearly indicate that the use of oil products promises the most successful and inexpensive methods for raising low type road surfaces and improvements to a condition satisfactory to meet the public demand.

At the present time, there are in this country over 1,000,000 miles of improved roads of types lower than waterbound macadam, and nearly 2,000,000 miles of unimproved roads, which might be advantageously treated with asphaltic materials. Taking into account original treatments and re-treatments, Mr. James estimates that asphaltic oils could be used to advantage on the following mileage of roads annually:

Bituminous macadam	4,800
Waterbound macadam	30,000
Gravel	292,500
Graded earth and sand clay.....	694,600

1,021,900 miles.

The total quantity of oil required for such an annual program would be approximately 8,470,000,000 gallons (201,667,000 42-gallon barrels). If to the above mileage is added that of the newly graded and drained earth roads that are advanced each year from the unimproved classification, a grand total of approximately 9,000,000,000 gallons (214,286,000 42-gallon barrels) or nearly 36,000,000 tons would be needed.

Mr. James points out that, while this theoretically possible annual use of road oils could not be actually reached, it indicates a most favorable opportunity for a huge expansion of the road oil market, limited only by present refinery capacity. He considers a fifth of the theoretical maximum annual consumption to be quite a practicable development from the standpoint of production and highway financing. This would amount to about 1,800,000,000 gallons of road oil (42,857,000 42-gallon barrels) as against some 70,000,000 gallons (1,667,000 42-gallon barrels) reported for 1927.

Conditions at the present time are exceedingly favorable to rapid and extensive expansion in low cost road construction as a farm relief measure. Remote country and farming districts would be given a fair proportion of the advantages of localities now favored with high-class road construction. Motor vehicle operation in the country districts would be increased; and the improved country roads, which could serve as admirable bases for more expensive types of pavements, in future would materially assist in decreasing the congestion on main highways.

POSSIBLE PETROLEUM SUBSTITUTES

OIL POSSIBILITIES FROM SHALE

The Federal Oil Conservation Board Report II, on "Possible Petroleum Substitutes and the Development of Shale Oil," quotes Dean E. Winchester, former government geologist and later consulting geologist of Denver, as estimating the recoverable oil from oil shales, "if and when the price warrants its extraction," as "92 billion barrels," or more than eight times the total quantity of well oil that has been produced in the United States to date.

ESTIMATE OF OIL RECOVERABLE FROM TERTIARY OIL SHALES

State	Total oil	Recoverable oil
Colorado.....	79,625,998,000	47,625,598,000
Nevada.....	6,039,000	3,623,400
Utah.....	42,800,000,000	25,680,000,000
Wyoming.....	3,044,000,000	1,826,400,000
Total ¹	125,476,037,000	75,335,721,000

¹ This estimate does not include small amounts of oil shale known or reported in the States of California, Montana, and Oregon.

Authority: Dean E. Winchester, Federal Oil Conservation Board Report II.

ESTIMATE OF OIL RECOVERABLE FROM DEVONIAN BLACK SHALES

State	Total oil	Recoverable oil
Indiana.....	7,680,000,000	6,912,000,000
Kentucky.....	10,978,560,000	9,880,704,000
Total ¹	18,658,560,000	16,792,704,000

¹ No estimate is made for the States of Ohio and Tennessee, although it is recognized that there are doubtless areas of minable shale in these states.

Authority: Dean E. Winchester-Federal Oil Conservation Board Report II.

ESTIMATE OF OIL RECOVERABLE FROM CANNEL SHALES

State	Total oil	Recoverable oil
Pennsylvania.....	13,800,000	8,280,000
West Virginia.....	13,800,000	8,280,000
Total.....	27,600,000	16,560,000

Authority: Dean E. Winchester, Federal Oil Conservation Board Report II.

For the United States, then, it is estimated that a total of 92,144,935,000 barrels of oil may be manufactured from oil shales and similar deposits, Mr. Winchester states.

The U. S. Bureau of Mines, in a statement contained in the Federal Oil Conservation Board Report II, says:

“ The oil shale deposits of the United States offer an assured supply of oil for many years, if and when the price of petroleum products reaches a level where the extraction of oil from these deposits is profitable.

“ There are many problems of a technical nature relating to the mining and retorting of oil shale and the refining of shale oil that must be solved before an oil shale industry could be established on a sound basis. Likewise, there are a number of complicated economic problems that must be taken into consideration before a profitable oil shale industry could be developed.

“ Many of those who have given serious consideration to an oil shale industry of the future are of the opinion that only operations on a very large scale, involving a commensurately large capital outlay, could hope to prove successful.

“ Doubtless the oil shale industry of the United States will have a slow growth, and oil from shale will supplement rather than displace oil from wells. When the demand for petroleum products exceeds the supply of crude oil that can be produced in this country or imported at prices below the cost of producing oil from shale, it is very likely that a few shale oil plants will be built, and the number may increase as it is definitely determined that the discovery of new oil fields will not again upset the price of crude petroleum. It will doubtless be difficult to interest capital in an oil shale industry until the peak of production from wells has been reached and the curve shows a definite decline, or until the demand exceeds the supply for a period of a few years.”

PRODUCTION OF OIL FROM COAL AND LIGNITES

The U. S. Bureau of Mines summarizes the possibilities of the production of oil from coal and lignites (Federal Oil Conservation Board Report II) as follows:

“ The original reserves of bituminous, subbituminous, and semibituminous coal in the United States within 3,000 feet of the surface have been estimated at 2,482,545,000,000 tons. Approximately 20,000,000,000 tons (or less than 1 per cent) have been mined, or lost in mining, leaving a reserve of about 2,460,000,000,000 tons. This coal will yield an oil somewhat similar to petroleum and assures us of an adequate reserve of oil for centuries to come, provided, of course, the demand and price would justify its extraction. It has been estimated that this amount of coal would yield 525,000,000,000 barrels of heavy liquid fuel or 92,000,000,000 barrels of motor fuel. No estimates are available as to the cost of obtaining products similar to petroleum from this source, but almost everyone is agreed that it is considerably above current prices for the different products.

“ The reserves of lignite in the United States are estimated at about 940,000,000,000 tons, capable of yielding 70,000,000,000 barrels of liquid fuels or 12,000,000,000 barrels of motor fuel. Again it is a question of price as to when these products could be made available.

“ The production of oil from coal and lignite offers certain advantages over the use of oil shale for that purpose, in that the deposits are found in almost every section of the country, some of the largest deposits being near important marketing centers. Also, the residue from the distillation of coal and lignite is a valuable fuel, whereas spent shale is practically worthless and its disposal means an additional expense in the production of oil. As in the case of the oil shale deposits, some of the large deposits of coal are in semiarid districts where there is the problem of obtaining an adequate supply of water for mining, retorting and refining operations. Owing to the movement toward elimination of smoke in the cities, it is possible that coal will be distilled in increasing amounts for the production of smokeless fuel and that liquid products will continue to be by-products of the distillation process. In case distillates are produced only as by-products and smokeless fuel is the main product of the industry, the production of substitute fuels would amount to

only a small percentage of the present production of petroleum products since the market for the main product would be limited to, something less than the consumption of bituminous coal.”

UTILIZATION OF AGRICULTURAL PRODUCTS FOR THE PRODUCTION OF MOTOR FUELS

The Bureau of Chemistry, U. S. Bureau of Agriculture, goes into the possibilities of the utilization of agricultural products for the production of motor fuels in the Federal Oil Conservation Board Report II.

The following substances of agricultural origin have been employed or proposed as a substitute for gasoline in the operation of motor engines :

1. Alcohol from the fermentation of grain, molasses, and other agricultural products.
2. Vegetable oils, such as palm oil, cottonseed oil, etc.
3. Agricultural dusts, such as grain dust, flour, etc.
4. Gas and other products from the destructive distillation of straw, cornstalks, sawdust, etc.
5. Furfural from the steam distillation of corncobs, hulls, and other cellular waste.

APPENDIX

CONSERVATION OF PETROLEUM

CHRONOLOGY OF DEVELOPMENTS *

The Federal Oil Conservation Board made its second report on January 16, 1928. It warned that existing methods of producing oil were wasteful to an alarming degree, due largely to the impossibility of conserving oil underground because leasing and royalty practices encouraged competitive drilling. Future shortage must be avoided, the Board said, or manufacturing productivity would be curtailed.

The report, which dealt chiefly with oil substitutes and shale oil development (see "Possible Substitutes for Oil"), estimated the quantity of oil recoverable from shale as 92,000,000,000,000 barrels, but pointed out that the question of production costs had not been answered and that oil from shale sources would not immediately be available, since shale oil operations still were in the experimental stage. Coal was held to be a potential source of 2,500,000,000,000 barrels of motor fuel. Lignite deposits were estimated to be capable of supplying another 12,000,000,000 barrels. Alcohol, derived from corn, and molasses, a by-product of sugar cane, also were suggested as possible sources.

More efficient use of petroleum products was held to be a conservation measure, and the Board recommended continued study of improved refining processes, as well as the possibility of developing more economical gasoline motors.

"The cooperation asked of the oil industry by the Federal Oil Conservation Board," the report said in discussing the problems of the industry, "has now become an effective working force for the betterment of conditions. . . . The interest in oil conservation as a practical policy is now well exhibited in the increased attention given to the strengthening of the production departments of the large companies by the enlistment of engineers of highly specialized training. . . . A notable sign of the times is the indorsement given to oil conservation by the technical and trade press."

* See "Petroleum Facts and Figures" first edition, page 227, for chronological summary of developments in conservation movement, 1924 through 1927.

COMMITTEE OF NINE REPORT

The Committee of Nine, organized December 10, 1927 (see "Petroleum Facts and Figures," first edition) to study enabling legislation, made its first report to the Federal Oil Conservation Board on February 6, 1928. It recommended enactment of federal and state legislation which would declare that agreements for cooperative development and operation of single oil pools were not in violation of the federal anti-trust laws and would permit, under suitable safeguards, the making, in times of overproduction, of agreements between oil producers for curtailment of production. The committee said that further study of waste of natural gas should be made in order that prohibitory legislation might be formulated without working injustice and unreasonable hardship, and presented a tentative bill for possible action by Congress. The bill was designed to promote conservation of petroleum and natural gas, to prevent waste thereof, and to encourage the establishment and maintenance of underground reserves of such minerals, and for these ends to authorize certain agreements.

As a direct result of the recommendations of the committee, Secretary of the Interior Work, then chairman of the Federal Oil Conservation Board, on March 1, 1928, sent letters to governors of the oil producing states asking their views on the possibility and probability of uniting in a program of uniform state legislation designed to legalize development of oil pools in the most efficient and economical manner, through agreements between companies if necessary. The trend of thought in the oil industry was decidedly in favor of remedial action, Secretary Work wrote, and this viewpoint was also the Board's.

INDUSTRY'S PRO-RATION ACTIVITIES

The industry continued to proceed with conservation measures as far as the law allowed. Thus on March 10, 1928, the Texas Railroad Commission, answering the request of producers, appointed a committee of six to consider the feasibility of limiting production of the prolific Hendricks Field under a pro-ration agreement similar to those already effective in the Seminole and Yates Fields. Members of the Mid Continent Oil & Gas Association, on March 23, 1928, also appointed a committee to consider a restriction program, especially in connection with wildcat drilling. On April 21 the committee reported favorably, and operators in Kansas and Oklahoma fields adopted its recommendations to eliminate unnecessary wells

and to curtail production of wildcat wells then under way, and appointed a committee to act under the umpire of the Seminole Field. The Texas Railroad Commission on April 24 issued an order, effective May 5, holding allowed production in the Hendricks Field to 150,000 barrels a day for six months on the pro-ration plan. About the same time plans were made to obtain pro-ration orders for Howard County, and the idea of restraining production gradually spread to other fields and other states where overproduction was becoming detrimental to the industry. As early as May 1927, operators in the Ventura Field of California had sensed the danger and cooperatively worked out a pro-rationing program endeavored to conserve oil and prevent waste of gas by establishing pro-ration periods. Later the plan was adopted in other California fields.

The American Petroleum Institute organized a Division of Development and Production Engineering, and a broad program for improving production methods and increasing efficiency of oil recovery was instituted at a general meeting of the division at Colorado Springs on June 16, 1928. Operators, engineers, and field men were gathered into district associations of the division for a discussion of problems peculiar to their areas.

Conservation measures were broadening in scope largely through further adoption of pro-ration agreements in the flush fields, when in an effort to establish such policies on a still wider basis a conference of representatives of the larger producing companies was called for July 30, 1928 at New York for informal discussion of the entire problem. Discussion concerned even too rapid development of the fertile oil fields of northern South America, and a committee was appointed to make a general survey of the situation. Matters assumed a worldwide aspect when in August representatives of American, British and Dutch oil companies discussed various phases of the subject abroad.

Meanwhile existing curtailment measures were given at a court test, and on September 4, 1928, at Tulsa, Federal Judge Vaught dissolved a temporary order, obtained by an oil company, which restrained the Oklahoma State Corporation Commission from enforcing its pro-ration order in the Little River Field. This move was regarded in effect, as upholding the commission's pro-rating policies in the Greater Seminole area. Two days later the commission issued a new order limiting daily production in all flush fields under its jurisdiction to 700,000 barrels daily for the rest of 1928.

Indication that the need of oil conservation was worldwide was seen at the annual meeting of the American Petroleum Institute at Chicago, when on December 6, 1928 Sir John Cadman, chairman of the Anglo-Persian Oil Co., of England, called for world cooperation in the development of petroleum resources as a means of stabilizing the entire oil industry.

BAR ASSOCIATION COMMITTEE REPORT

On December 26, 1928, a Committee on Conservation of Mineral Resources, appointed from its membership by the American Bar Association, reported on its study of the need for uniform state legislation to permit cooperative or unit development and operation of oil and gas pools, and presented drafts of two laws recommended for enactment. One measure was designed to legalize voluntary agreements for economic purposes and conservation by removing the obstacles raised by state anti-trust laws; the other provided for compulsory unit and cooperative development and operation by invoking state police powers.

"The inquiry of your committee," the report said, "has involved serious economic questions as well as debatable propositions of law. We are convinced that the American petroleum industry will never find its proper place in our economic structure until it solves the problems that arise from competitive drilling and operation of oil and gas pools. Whether that is to be accomplished by voluntary action in the industry or by compulsion of law is yet to be determined. After an extended inquiry into the two possibilities, we have reached the conclusion that, by force of circumstances entirely beyond the control of the industry, comprehensive voluntary action is improbable, if not impossible. Upon the basis of this conviction your committee proposes one compulsory measure."

In January 1929, President Reeser, following the Annual Meeting of the American Petroleum Institute, appointed a national committee to study and report on the petroleum situation. The members were: L. P. St. Clair, M. E. Lombardi and S. A. Guiberson, Jr., representing the California district; S. H. Keoughan, Rocky Mountain; W. C. Franklin, W. G. Skelly, W. S. Fitzpatrick, H. V. Foster and A. M. Landon, Oklahoma-Kansas; W. S. Farish, W. H. Francis and J. S. Bridwell, Texas-New Mexico; and M. J. Grogan, Louisiana-Arkansas.

Conservation again entered actual field practice on February 5, 1929, when operators in the Greater Seminole area met at

Tulsa and formulated plans to curtail Oklahoma production by reducing the production of flush fields, effective February 14, 1929.

INSTITUTE'S RESOLUTION

Directors of the American Petroleum Institute at St. Louis, on February 11, 1929, received and approved the report of the National Committee, and adopted its resolution recommending the enactment of state laws to prevent waste of gas and to permit cooperative development of single pools and authorizing the president to appoint such committees and to take such steps as necessary to protect the industry from the evils of overproduction and the country from dangerous waste of national petroleum resources. Another resolution adopted pledged the directors, as executives of companies producing oil from pools where overproduction was imminent, to use their full powers through legal cooperative methods to prevent the development of overproduction and of attendant waste. The resolutions follow:

LEGISLATION

“WHEREAS, The committee appointed by the president of this Institute to study and determine the conditions existing in the oil industry finds that there is an imminent overproduction of oil which, if not regulated, threatens to become acute and to result in the flow of oil into unnatural channels of consumption to the disadvantage of the industry, and in the use for inferior purposes of this most valuable, limited, and irreplaceable natural resource to the serious injury of the public; and

“WHEREAS, This overproduction of oil is due to present competitive methods of producing oil, which result also in great physical waste of both oil and gas through the failure, among other things, to recognize and observe the principle that the prevention of the waste of natural gas found in oil producing formations is of paramount importance in connection with the economical production and conservation of oil; and

“WHEREAS, The waste of gas cannot be prevented in an oil pool where there is diversified ownership as long as any one operator, through ignorance of the above principle, or through selfish disregard for the correlative rights of his neighbors, or through desire to capture more oil than underlies his property, disregards the above principle and continues physically to waste gas and oil and refuses to cooperate with his neighbors in accepting preventive measures,

“NOW, THEREFORE, BE IT RESOLVED: That we, the Board of Directors of the American Petroleum Institute, favor the enactment of laws to prevent the waste of such gas by the various oil producing states in which natural gas is being unnecessarily wasted;

“BE IT FURTHER RESOLVED: That we favor the enactment of laws in the various oil producing states that will permit agreements between operators in a single pool for the orderly development of oil and gas holdings therein, and the enactment of laws vesting in some public authority the power to prevent, not only such unnecessary waste of gas, but also to prevent the continuance of drilling and producing practices which result in underground physical waste of oil or gas—including the power to make and enforce orders prorating the production of oil in a pool between the several leases therein, and establishing and carrying out a program for the orderly development of a pool through the orderly development by each operator of his separate holdings therein;

“BE IT FURTHER RESOLVED: That the president be, and he is hereby authorized, to appoint such committees and take such steps as may be necessary to cooperate fully with other agencies in the accomplishment of these purposes; and that he be instructed to file a copy of this resolution with the Federal Oil Conservation Board.”

COOPERATION

“WHEREAS, We, the Board of Directors of the American Petroleum Institute, have this day by resolution favored the enactment of laws by the various oil producing states where natural gas is being unnecessarily wasted to prevent such waste; and

“WHEREAS, The now imminent overproduction of oil threatens to develop an acutely serious situation before such legislation can become effective,

“NOW, THEREFORE, BE IT RESOLVED: That, pending the enactment of the appropriate laws, the members of this board, in their capacities as executives of companies producing oil from pools where overproduction is imminent, hereby pledge their full powers through all legal cooperative methods to prevent the development of such overproduction with its attendant waste.”

COMMITTEE ON WORLD PRODUCTION AND CONSUMPTION

A Committee on World Production and Consumption of Petroleum and Its Products was then created by President Reeser of the Institute, with a membership of roundly 80 principal executives of oil companies representing the producing areas of the United States and northern South America. Its personnel is as follows:

GENERAL COMMITTEE

- R. C. Holmes, *General Chairman* (The Texas Company, New York).
K. R. Kingsbury, *Chairman*, Pacific Coast Regional Committee.
W. M. Irish, *Chairman*, (F. R. Coates, Vice Chairman) Gulf and Atlantic Coast Regional Committee.
W. C. Franklin, *Chairman*, Interior Regional Committee.
E. J. Sadler, *Chairman*, Mexico and Northern South America Regional Committee.

And

- Two members selected by Pacific Coast Regional Committee:
L. P. St. Clair, G. Legh-Jones.
Two members selected by Gulf and Atlantic Coast Regional Committee: Henry M. Dawes, W. C. Teagle (Alternates: Axtell J. Byles, W. S. Farish).
Two members selected by Interior Regional Committee: B. H. Stephens, Roy B. Jones (Alternates: W. S. Fitzpatrick, W. N. Davis).
Two members selected by Mexico and northern South America Regional Committee: R. G. Stewart, Richard Airey (Alternates: C. F. Meyer, A. E. Watts).

PACIFIC COAST REGIONAL COMMITTEE

- K. R. Kingsbury, *Chairman*, Standard Oil Co. of California, 225 Bush Street, San Francisco.
William F. Humphrey, Associated Oil Co., San Francisco.
R. A. Broomfield, Barnsdall Oil Co., Los Angeles.
Ward Blodgett, Chanslor-Canfield Midway Oil Co., Los Angeles.
D. S. Ewing, Ethel D Co., San Francisco.
Lionel T. Barneson, General Petroleum Corp., Los Angeles.
H. P. Grimm, George F. Getty, Inc., Los Angeles.
A. C. Diericx, Honolulu Consolidated Oil Co., San Francisco.

- R. S. MacMillan, MacMillan Petroleum Products Co., Los Angeles.
W. C. McDuffie, Pacific Western Oil Co., Los Angeles.
E. L. Doheny, Petroleum Securities Co., Los Angeles.
C. M. Fuller, Richfield Oil Co., Los Angeles.
G. Legh-Jones, Shell Co. of California, San Francisco.
W. M. Keck, Superior Oil Co., Los Angeles.
C. E. Olmsted, Texas Co. of California, Los Angeles.
L. P. St. Clair, Union Oil Co., Los Angeles.
Roy N. Bishop, Universal Oil Co., San Francisco.
George L. Machris, Wilshire Oil Co., Los Angeles.

GULF AND ATLANTIC COAST REGIONAL COMMITTEE

- W. M. Irish, *Chairman*, Atlantic Refining Co., Philadelphia.
C. F. Cullinan, American Republics Corp., New York.
Frank R. Coates, Cities Service Co., New York.
E. H. Buckner, Houston Oil Co. of Texas, Houston.
W. S. Farish, Humble Oil & Refining Co., Houston.
E. R. Brown, Magnolia Petroleum Co., Dallas.
Henry M. Dawes, Pure Oil Co., Chicago.
J. C. Van Eck, Shell Union Oil Corp., New York.
H. F. Sinclair, Sinclair Consolidated Oil Corp., New York.
W. C. Teagle, Standard Oil Co. (New Jersey), New York.
Herbert L. Pratt, Standard Oil Co. (New York), New York.
J. Howard Pew, Sun Oil Co., Philadelphia.
R. C. Holmes, The Texas Co., New York.
Axtell J. Byles, Tide Water Associated Oil Co., New York.
George P. Whaley, Vacuum Oil Co., New York.
M. F. Yount, Yount-Lee Co., Beaumont.

INTERIOR REGIONAL COMMITTEE

- W. C. Franklin, *Chairman*, Tidal Oil Co., P. O. Box 2046, Tulsa.
E. DeGolyer, Amerada Petroleum Corp., New York.
E. H. Blum, Atlantic Producing Co., Dallas.
S. H. Keoughan, Continental Oil Co., Denver.
H. R. Straight, Empire Gas & Fuel Co., Bartlesville.
Wirt Franklin, Wirt Franklin Petroleum Corp., Ardmore.
E. H. Moore, Independent Oil & Gas Co., Tulsa.
H. V. Foster, Indian Territory Illuminating Oil Co., Bartlesville.
Ben H. Stephens, Magnolia Petroleum Co., Dallas.
D. J. Moran, Marland Oil Co., Ponca City.
Jacob France, Mid-Continent Petroleum Corp., Tulsa.

Thomas A. Dines, Midwest Refining Co., Denver.
Frank B. Fretter, National Refining Co., Cleveland.
O. D. Donnell, Ohio Oil Co., Findlay.
Roy B. Jones, Panhandle Producing & Refining Co., Wichita Falls.
J. F. O'Donohue, Petroleum Producers Co., Wichita Falls.
W. N. Davis, Phillips Petroleum Co., Bartlesville.
W. S. Fitzpatrick, Prairie Oil & Gas Co., Independence.
R. W. McIlvain, Pure Oil Co., Chicago.
John L. Gray, Shaffer Oil & Refining Co., Tulsa.
U. deB. Daly, Shell Petroleum Co., St. Louis.
W. G. Skelly, Skelly Oil Co., Tulsa.
E. W. Sinclair, Sinclair Consolidated Oil Corp., New York.
L. W. Young, South Penn Oil Co., Pittsburgh.
R. W. Stewart, Standard Oil Co., (Indiana), Chicago.
W. E. Smith, Standard Oil Co. (Kentucky), Louisville.
W. T. Holliday, Standard Oil Co. (Ohio), Cleveland.
J. Edgar Pew, Sun Oil Co., Dallas.
R. Ogarrio, The Texas Co., Houston.
E. J. Marston, Texas & Pacific Coal & Oil Co., Fort Worth.
F. B. Parriott, Transcontinental Oil Co., Tulsa.
H. B. Earhart, White Star Refining Co., Detroit.
A. M. Landon, Independence.
J. H. Markham, Jr., Tulsa.
Thomas B. Slick, Oklahoma City.
L. H. Wentz, Ponca City.

MEXICO AND NORTHERN SOUTH AMERICA REGIONAL
COMMITTEE

E. J. Sadler, *Chairman*, Creole Petroleum Co., 26 Broadway,
New York.
Herbert J. Carr, Anglo-Mexican Petroleum Co., New York.
Richard Airey, Asiatic Petroleum Co., New York.
George H. Smith, International Petroleum Co., Toronto.
R. G. Stewart, Pan American Petroleum & Transport Co.,
New York.
F. J. Huffman, Penn-Mex Fuel Co., Pittsburgh.
A. E. Watts, Sinclair Consolidated Oil Corp., New York.

This committee was given a three-fold mission in a letter by President Reeser, who said:

"It is well known that most of the important oil fields throughout the world are producing an amount of crude in excess of the consumption in the markets geographically tribu-

tary thereto. This overproduction has developed such an acutely serious situation that the most complete cooperation lawfully possible is essential to prevent its further development and attendant waste.

"Each regional committee is urged to meet promptly, and engage in discussions and cooperative action to hasten adjustment and assist in solving the problem; and in order that the General Committee, which will be composed of R. C. Holmes as general chairman, together with the chairmen of the regional committees, plus two additional members to be selected by each of the regional committees themselves, may have before them for consideration at least four suggestions of general plans, it is suggested that each regional committee give consideration:

"First: To analyzing the problem of production and consumption of petroleum and its refined products, not only in the territory for the region of your committee, but of the world—giving particular attention, however, to the determination of methods whereby your particular area can lawfully adjust itself to the problem of producing as nearly as possible only such quantity of oil as will supply its own natural geographical market.

"Second: To prepare and present a report to the General Committee, indicating conclusions reached as to its own area and suggestions for the proper and effective application of your plan and the part this area can, and will, endeavor to play in cooperative action with the other regions, looking toward properly balancing overproduction at least in the Western Hemisphere.

"Third: It is suggested that if such cooperative measures as you may determine desirable, either in your own region or other regions, do not appear to be feasible because of existing laws or other difficulties, your committee shall make suggestions for such corrective measures as would appear to be helpful in arriving at the solution of the general problem before us.

"The committees should not feel limited in the extent to which they should study the entire problem and activities in other branches of the industry which might, through proper cooperation or regulation, assist in improvement in the production and economic situation."

THIRD REPORT OF OIL BOARD

The Federal Oil Conservation Board, under date of February 25, 1929, made its third report. The report said that excess

production commented upon when the Board was appointed in 1924 "unfortunately continues" and had kept ahead of a 20 per cent gain in demand. "The question of future supply thus continues to be a matter of public concern, even though it is given little thought by our citizens generally," it was explained. The report added, however, that the petroleum industry evidently had sensed the danger and, "fortunately for the public interest, the trend in the operating policy of the stronger companies has been definitely in the direction of conservation."

Intentional delay in developing fields whose production is not immediately required, offset agreements to retard development in proved areas, pro-rating flush flows to prevent market flooding, and shutting in production to a volume never before approached were cited as features of an "accomplishment that affords the best evidence of the possibility of a high degree of self-regulation in the business of bringing oil to the surface."

Discovery of new fields and of deeper sands in old fields, development of conservation engineering in field and refinery, recovery of larger proportions of oil, appreciation and utilization of the true function of gas in bringing oil to the well and to the surface, and a trend toward cooperative effort in operating new fields and rejuvenating the old were termed factors which had "materially increased estimates of assured future supplies."

Complete organization of cooperative efforts, recommended in the first report (see "Petroleum Facts and Figures," first edition), had not been attained, but more progress has been made than was expected, the Board said, explaining: "The keen and sustained attention given to the study of new methods, the many conferences held, the large number of working committees organized within the industry and the cooperative spirit with which different units have worked together are all indicative of a new appreciation of responsibility."

The Board reported progress in development of uniform legislation designed to legalize voluntary agreements for economic purposes and conservation by removing obstacles imposed by state anti-trust laws and to provide for compulsory unit and cooperative development and operation of oil pools. In fact, unit operation, an objective of the industry, was held to be the essential factor in handling underground reserves of oil, the Board commenting that "the possibility of unrestrained individual action in what should await regulated community action still remains a menace to the present stabilized rate of production."

Proposal to leave the oil underground until needed also met approval, the Board declaring that method best because safest and cheapest. The Board stressed the international aspect of the situation by recalling that this country was producing more than two and one-half times and consuming nearly twice as much petroleum as the rest of the world.

"Neither the high rate of domestic consumption, nor the excess of exports over imports would be disquieting," it was said, "if the petroleum resources of the United States bore anything like the same ratio to the world's resources as the production ratio of 68 per cent. According to the present opinion of our best petroleum geologists, our total resources, instead of being 68 per cent of those of the whole world, are not more than 18 per cent. If our petroleum reserves are not to be drawn upon at a faster rate than those of all other countries, our resources should be several times larger. The obvious inference is that the United States is exhausting its petroleum reserves at a dangerous rate."

Cooperation in the development of foreign oil fields, such as those of Mexico and South America, through technical assistance and the further investment of American capital, and importation of a greater quantity of crude petroleum, were recommended as means of bringing the depletion rate more in accord with that of foreign resources.

REPORT OF WORLD COMMITTEE

The first report of the Committee on World Production and Consumption of Petroleum and Its Products was formulated at a meeting of the Institute at Houston, Tex., on March 15, 1929, in the presence of federal and state government representatives. The committee recommended that 1928 production of crude oil in the United States should be considered as the peak of requirements for 1929 and following years, and proposed that, beginning April 1, 1929, average production should be held to the level of 1928, provided that plan met the approval of the directors of the Institute and of the Federal Oil Conservation Board and state conservation agencies. The committee recommended also that a permanent organization be set up within the Institute for a study of all phases of conservation and proper production and use of petroleum products, not only in the United States but throughout the world. This resolution was adopted:

"WHEREAS, The Federal Oil Conservation Board has repeatedly called the attention of the country to the overproduction of crude oil and the consequent waste of this irreplaceable national resource, and has repeatedly invited the industry to cooperate with governmental agencies in improving the situation and has said, 'the complete organization of cooperative effort is recommended, with simple but effective working units that will insure full contact of the industry with both state and federal government and continuous contact of all operators in an oil field'; and

"WHEREAS, The state authorities of all the principal oil producing states have exhibited a keen interest in the subject and a desire to have the cooperation of the industry in formulating and carrying on an effective program;

"THEREFORE, BE IT RESOLVED: That the production of the four regional areas represented by the committees will be sufficient for 1929 to meet the consuming requirements of the territories which they supply, if the 1928 basis of production be adopted.

"BE IT FURTHER RESOLVED: That beginning, April 1, 1929, the average production of the four regions on a daily basis should not exceed the average daily production during the year 1928, and that each regional committee be requested to meet, either through its elective representatives on the general committee, or as a whole, with the general committee in New York, at the Institute, on the morning of the twenty-seventh, at 9 o'clock to report to the general committee whether or not the production in the respective regions can be brought to the 1928 average for that region.

"BE IT FURTHER RESOLVED: That in the event of favorable reports and the approval of the Institute, the action be at once submitted to the Federal Oil Conservation Board for its approval, and, if approved by the Federal Oil Conservation Board, that the state authorities in the principal oil producing states be at once advised of the proposed action which will become effective as the policy and program of the Institute, if approved by such state authorities."

CONSERVATION OF GOVERNMENT OIL

The oil conservation policies of President Hoover were made public on March 12, 1929, when he announced at a press conference that "there will be no leases or disposal of government oil lands, no matter what category they may lie in, of govern-

ment holdings or government controls, except those which may be mandatory by Congress. In other words, there will be complete conservation of government oil by this administration."

This policy was made effective on March 13, when the Commissioner of the General Land Office issued to all local land offices an order approved by Secretary of the Interior Wilbur reading:

"No oil and gas prospecting permits will be issued on and after March 12, 1929. Reject all applications for oil and gas permits now pending in your office and receive no more. All orders for drawings hereby revoked."

There was an immediate protest from governors of interested states, but the cancellation of permits to operate on government lands was begun. Later the order was modified slightly in cases where extensive work already had been done, but generally it was directed that government oil lands were to be closed tightly to oil development projects.

WORLD COMMITTEE REPORT APPROVED

The recommendations of the Committee on World Production and Consumption of Petroleum and Its Products were unanimously approved by the board of directors of the American Petroleum Institute at a meeting in New York on March 27, 1929, with a representative of the Federal Oil Conservation Board again present. The conservation movement assumed an international aspect with the promise of Sir Henri Deterding, managing director of the Royal Dutch-Shell interests, to give one hundred per cent cooperation in foreign fields.

The conservation plan recommended by the committee, contained in a letter addressed to President Reeser by Chairman Holmes, was ordered presented to the Federal Oil Conservation Board for approval. It follows:

"As instructed in your letter of February 20, the committees on Crude Oil Production and Conservation, consisting of four regional committees and a general committee, the latter consisting of three members from each regional committee, held their meetings; and the general committee at its meeting in Houston on March 15, after consideration of the regional committees' recommendations, submits the following for the information and consideration of the Board of Directors of the Institute:

"*First:* Study and consideration of this subject, covering the Western Hemisphere, have been given by a large and repre-

sentative portion of the producing interests. It is estimated that the 80 members of the regional committees alone represent directly 72.5 per cent of the domestic production and 88 per cent of the foreign production of the Western Hemisphere.

"Second: The years of the largest production with greatest excess over market requirements are the years in which the greatest waste, both actual and economic, occur.

"Third: It is recognized that the important and most essential products of crude petroleum are gasoline, lubricating oil, and kerosene; and while 912,000,000 barrels were consumed in refinery running in the United States during the year 1928 to produce the gasoline requirements on the basis of the average yield of 41.3 per cent of gasoline, it is known that certain units more fully equipped with cracking facilities and running a fairly representative average of the American crudes have produced materially larger yields of these required products, and it is estimated that a yield of at least 60 per cent of gasoline could be produced with present known and proven processes and in all probability at the same time produce the requirements of lubricating and other essential products, thereby making it possible to produce the 1928 market requirements from 628,638,000 barrels of crude.

"Fourth: The difficulties of immediately accomplishing all that is desired in the way of conservation were so apparent that it was considered we would be making a very creditable undertaking if we could take care of market requirements in 1929 from the amount of crude produced in 1928. It was, therefore, unanimously resolved by your committee, beginning April 1, 1929, the average production of the four regions on a daily basis should not exceed the average daily production during the year 1928 (for complete resolution see page 235).

"Fifth: We are in accord with the suggestion that the maximum production fixed for the year 1929 would probably be sufficiently high for possibly one, two, three or more years, through such gradual improvement in refinery processing as may produce the requirements of gasoline and other essential petroleum products; and that it is desirable that this figure for maximum crude production should not be increased until the maximum yield of these products, on the whole, has been accomplished.

"Sixth: That so long as serious overproduction exists in the world, a permanent organization within the American Petroleum Institute should be formed for study of the situation, not only in the United States, but throughout the world

Such an organization would work closely with the Department of Commerce and the Federal Oil Conservation Board for the freest possible dissemination of knowledge of conditions in the separate regions and in the aggregate.

"*Seventh:* That the present committees of the American Petroleum Institute, or new committees working under the general plan of the present committees, together with such subcommittees as the Board may consider desirable, take up for further study and action some of the topics suggested in the general chairman's address on March 15, and we make the following suggested outline in this connection:

" (1) *General Committee, to*

"(a) Ascertain whether Federal aid or legislation is now considered necessary, and if so, the extent and nature of such aid or legislation as would be needed to sustain control of production as well as to give the necessary support, if such authority is needed, to cooperate with other nations in the worldwide conservation and orderly development of petroleum deposits; and to deal, to whatever extent is necessary and desirable, and permissible, with the world situation, having in mind that this is possibly essential to the success of any real, effective conservation plan.

"(b) Determine whether we, as an American nation, should find it desirable to encourage the same degree of restriction and conservation on the part of foreign fields as of our own, or whether it would be in our interest to assume the larger share of restriction here at this time in order to prolong the life of our own fields or deposits.

"(c) Consider what may, and should be, the attitude of countries which are producing petroleum as differing from those countries which do not produce. Should not the countries without production have quite as much, if not more, interest in the conservation and control of production as those countries which are exhausting their known supplies? Take such action as may be necessary to create accurate representations and importance of the plan which we are undertaking.

"(d) Determine more accurately the extent to which crude production, as a whole, may possibly be reduced to bring about a satisfactory reduction in stocks and constitute a more substantial conservation.

“(e) Determine what can be properly undertaken to encourage a check on wasteful consumption of petroleum products as a part of the conservation activities.

“(f) Assume the responsibility for maintaining, with such national and state aid as can be secured, the orderly control of production and making of such adjustments from time to time as are necessary to make the plan workable and effect the purpose of same.

“(2) *Regional Committees*, together with such sub-divisions, or state committees as the Board or regional committees may find desirable to appoint, should consider the following:

“(a) The possibilities of such control with such co-operation as is possible within the industry today.

“(b) Whether state legislation is necessary, and if so, the precise nature of such required legislation in each of the states, particularly where the overproduction situation exists and where it may most likely be a problem in the future.

“(c) To what extent the regulation and control of gas production will contribute to the plan and be an aid to the permanent success thereof, and take action to bring about an acceptable and satisfactory solution of this feature of petroleum production.

“(d) To what extent more uniform leasing contracts and provisions for zoning, or unit operation, either voluntarily or by law, would be an aid, and try to agree upon a plan for such zoning as is essential in preventing extravagance and waste.

“(e) Determine what can be saved to the industry and to the consumer by a more orderly and more economic system of producing oil and of such drilling only in new developments as is necessary to clearly define the field and that will produce the oil under control, and compare this with the cost of waste of recoverable oil when there is no control, or when the oil is taken out rapidly, as in many instances, and water encroachments and gas depletion take place prematurely.

“(f) Ascertain the cost to the industry of storing and carrying such excess stocks as will probably accumulate if production continues at the present rate; and what can be saved if substantial underground deposits can be ascertained and maintained.

“(g) Determine what will probably be the effect of geophysical instruments and other scientific aids in locating

oil deposits, and the desirability of encouraging such activities and discoveries with a view of having more accurate knowledge of deposits, and the effect of such determinations in giving stability to the industry. The effect of such discoveries with or without control of production. Also the advantages of such determinations as against the difficulty, expense and delay of development in the event known supplies should decline below the actual minimum market requirements.

“(h) Determine the cost to the industry of the present fuel oil situation as against the markets and conditions applying when fuel oil prices were such that coal was on a competitive basis for steamship and shore installation, and ascertain what effect and advantages might be derived by the coal industry, and possibly railroads and other affected interests, if we were to reduce fuel oil manufacture by, say, 50 per cent under the 1928 production.

“(i) Determine as accurately as possible the probable recoverable oil from present known or producing fields of the world, as well as the opinion of those who are considered best qualified to determine or estimate the possible amount of oil that is yet undiscovered but that may possibly be made available in the future.

“(3) That the chairmen of these regional committees keep the chairmen of the other regional committees and the chairman of the general committee currently advised of work and developments of all these committees in order that all regions may have the benefit of the study and conclusions and activities of other regions.”

While the Institute was discussing its program in New York, California oil field operators were working out a practical field plan at Los Angeles and on the same day, March 27, decided to reduce state production of crude oil at least 138,000 barrels daily. An umpire was selected, and the plan shortly was put into effect, with still greater reductions in output made in ensuing months.

OIL BOARD HEARING

On April 3, 1929, the Institute placed its plan before the Federal Oil Conservation Board at a public hearing in Washington. President Reeser explained the situation, saying:

“The American Petroleum Institute is an association representing all phases of the petroleum industry; its membership

comprises at least 90 per cent of the production in the United States and approximately the same percentage of the total production in the entire Western Hemisphere.

"The activity of the Institute has heretofore been directed, more particularly, to the stabilization of equipment used in drilling wells, in the development of more efficient methods and appurtenances for handling the products which, as is well known, are very volatile and subject to rapid evaporation. It has given great attention to the preparation of a 'Code of Ethics,' a hearing on which was recently held before the Federal Trade Commission and by whom it is expected an approval will be given in the near future. The Institute has an organization working on problems looking toward a higher state of efficiency in the various departments of the industry.

"The Institute has for a long time viewed with alarm the rapid depletion of the petroleum reserves of the United States. Competitive conditions presented so many difficulties that it seemed almost hopeless to unite the industry on a broad, constructive policy which would balance production and consumption. Finally, however, following the suggestions in the reports of the Federal Oil Conservation Board, it was decided to undertake the effort.

"Universities have developed a science of petroleum engineering which has reduced the hazard of finding new supplies of petroleum and, after finding them, of bringing the product to the surface at a pace undreamed of a few years ago. Geologists, paleontologists, and engineers, with scientific instruments of all kinds, plus a keenly competitive practice between many well organized companies, have brought about a deplorable condition in the industry. It should be remembered, however, that nothing has been, or can be, developed to create new supplies—petroleum is an irreplaceable resource, and the use of modern methods in bringing it to the surface has only the effect of hurrying the date of exhaustion.

"Whereas other industries have taken advantage of the increased efficiency in transportation facilities by reducing inventories, the petroleum industry continues to add to its burden by bringing to the surface a valuable product which should remain in its natural tankage until required. The Bureau of Mines reports that in January and February of this year approximately 250,000 barrels per day of petroleum and its products were added to storage. The same authority showed that on December 31, 1928 stocks were 613,931,000 barrels. This enormous and excessive inventory is carried at a great cost and,

through the loss of the lighter elements by evaporation, a permanent loss is sustained.

"In considering the petroleum industry, it is seldom realized that the average production per day from wells in the United States is less than 8 barrels. This low average is due to the large number of very small wells. There are, at this time, over 220,000 wells yielding about one-half barrel per well per day. Obviously, many of these wells are being operated at a loss. The production curve on all wells is downward, and ultimately all reach the same point. They are located on constantly increasing areas. The production is relatively small, but it is very important that these wells be protected for the time when the large flush areas have been exhausted.

"In accordance with the resolution adopted by the Board of Directors of the American Petroleum Institute, the president appointed the committees to study conditions and to recommend what should be done to correct the situation. The territory was divided into four regions: The Pacific Coast, the Interior, the Gulf and Atlantic Seaboard, Mexico and South America. Eighty leaders from various fields, together with a large number of statisticians, have given liberally of their time in an attempt to solve the problem. A general committee, under the chairmanship of R. C. Holmes, consolidated the several regional reports. The Oklahoma Corporation Commission, the Texas Railroad Commission, the California Conservation Board, and a representative from your honorable board have been present at our meetings and cooperated with the committee.

"Finally, on March 27, upon the recommendation of the general committee, the Board of Directors of the Institute unanimously adopted and approved the report of the general committee.

"A great effort has been made to comply with the general plan, or procedure, recommended by your board. The future welfare and prosperity of the nation may depend upon the success of this movement. We cannot hope to succeed in our efforts without the continued help and cooperation of governmental agencies and, in fact, the Institute would not wish to continue its activity without the approval of your board. We, therefore, request the approval of the plan by your honorable board."

Chairman Holmes, of the committee which made the report, then presented a record of the proceedings of the Institute in connection with the promotion of oil conservation.

ATTORNEY GENERAL'S LETTER

The reply of the Board came from Chairman Wilbur, who explained that naturally the Board was most sympathetic with the desire of the industry for control of an exhaustible resource. "So I wrote a letter to the Attorney General," he said, "asking him to write to the Board in an informal way stating his judgment in respect to the functions of this Board." Attorney General Mitchell's letter dated March 29, 1929, follows:

"I have the letter of March 20 written by you as chairman of the Federal Oil Conservation Board, enclosing a copy of a resolution adopted by a committee of the American Petroleum Institute at Houston, Tex., on March 16, 1929, proposing that those engaged in the production of petroleum agree to limit production in certain areas in 1929 to the amount produced in 1928, provided that such action be first approved by the Federal Oil Conservation Board and by the authorities in the states affected.

"The questions you submit for my opinion are whether the Federal Oil Conservation Board has power to approve the proposed agreement and what, if any, effect such approval might have in relieving the parties to the proposed agreement from the operation of acts of Congress forbidding agreements in restraint of interstate commerce. You also inquire whether the proposed agreement would violate the anti-trust laws of the United States.

"The Federal Oil Conservation Board was constituted December 19, 1924, by an executive order naming the Secretaries of War, Navy, Interior and Commerce. There was no act of Congress then in force defining the duties or powers of the Board, and there has been no legislation since dealing with the Board, excepting appropriation acts, commencing with the act of January 20, 1925 appropriating funds for the expenses of the Board.

"It is clear that Congress has not given the Board any power to grant to any persons immunity from the operation of acts of Congress prohibiting agreements in restraint of interstate commerce, and that the Board has no authority to approve any action which is contrary to an act of Congress or to the anti-trust laws of any state; and that no action taken by the Board would have the effect of relieving parties to such an agreement from the operation of the anti-trust laws of the United States and of the states. The proceedings of the American Petroleum Institute indicate that the purpose of submitting the proposed

agreement to the Federal Oil Conservation Board for approval is to obtain a sanction from the federal government which may operate to make the parties to the agreement immune from the operation of the anti-trust laws. For the Federal Conservation Board to grant approval under such circumstances would be assuming authority which it does not have.

"The Board's only duties are to investigate and study for the purpose of recommending methods of conservation, and not with the intent that its action in approving or disapproving any plan would have any legal effect on the validity of the plan proposed. As the powers of the Board are limited in this way, the question whether the proposed agreement would violate the anti-trust laws of the United States is apparently not a question arising in one of the executive departments on which the Attorney General is authorized by law to give an opinion. Furthermore, it is not the practice of attorneys general to give opinions as to whether proposed action by private persons would violate the laws of the United States.

"The proceedings of the Petroleum Institute make it clear that its members already realize that under existing laws such an agreement could not safely be made without the sanction of some officials of the United States authorized to give it and, as I have already pointed out, no such authority exists."

SECRETARY WILBUR'S LETTER

On April 8, 1929, Secretary Wilbur wrote Chairman Holmes, of the general committee, as follows:

"The Board has now given consideration to questions affecting the waste of oil due to the present large overproduction. I may recall that at our meeting with your directors resolutions were presented which had been adopted by the American Petroleum Institute proposing restriction of the production of petroleum in the United States during the year 1929 to an amount not in excess of the 1928 production, and asking the approval of the Board to such a course.

"As explained to the directors of the Institute, the Oil Conservation Board possesses no authority to approve such an agreement as that proposed, and the Board is advised that any such action on the part of the Institute would possibly constitute a violation of the Sherman Act. It would further appear that the joint legal committee appointed in December 1927, of which three members were chosen by the American Bar Association, three by the government, and three by the Petro-

leum Institute, came to the same conclusion and recommended legislation.

"Purely negative action does not cure the prime difficulty—the rapid waste of our oil resources. The purpose of the Board has been to find a constructive method for the prevention of the present reckless waste of oil, and it naturally sympathizes with every practicable step.

"As you are aware, the investigations of the Board over the past few years have demonstrated large wastes in the production and utilization of our oil, and an alarming prospect as to our future supplies. Its conclusions, in which it has been confirmed by scientific investigation and a considerable part of the industry, were that in the long view the positive method of conservation is the initial control of development through the control of drilling, to the end that upon discovery of a new oil pool a plan for its development should be established which would prevent the waste of gas, the consequent loss of gas pressures and its serious effect upon the total yield of the pool, and to prevent other great losses which arise from flush flows due to periodic overproduction, from feverish competition and offset drilling, with its consequence in unnecessary diversion of oil from gasoline to fuel on such occasions. Had such control been in action during the last three years, not only would the present situation not have arisen, but the vast present waste of oil by diversion from gasoline to fuel would not be taking place. While such a course could not be wholly applied to old pools, it could be made effective in new pools and new strata. It is upon this program that the Board has sought cooperation of the industry. To solely close off production temporarily to relieve present congestion and stop the immediate waste of gasoline to fuel it would not affect the real problem—that is, the long view wastes mentioned above.

"It was determined by the legal advisory committee above mentioned that there were no constitutional grounds upon which the federal government could impose such a regulation of drilling, but that the sole legal authority for such action lies within the state governments themselves. Suggestions were made which have been or are in course of discussion in the legislature in various oil producing states.

"The problem appears to the Board, therefore, due to the legal inhibitions, to be one in the real solution of which action must be secured from the different states. The Board recognizes that individual state action without coordination would not cover the question, but with a view to bringing about such

a program and its coordination, the Board believes it would be worth while to renew discussion with the state authorities of the three or four principal oil producing states, particularly to learn if it is not possible for them to enter upon an interstate compact under the provisions of the Constitution authorizing such compacts to which the federal government, through congressional action, would be a party. The character of such a compact would need much consideration, but it could well comprise creating a joint board for the purposes of constructive conservation and thus secure the nation from the very real peril that will lie in the reckless exhaustion of our oil resources. With this in view, the Board is planning to have Dr. George Otis Smith, on its behalf, visit and interview the governors of three or four dominating oil producing states and learn their views upon such a proposal.

"It believes that the above suggestion, if it can be consummated on constructive lines, should extend the life of our oil resources and give greater stability to the industry; should vastly increase the returns to those states, and at the same time should protect the consumer."

On April 24, 1929, the Board of Directors of the Institute at a meeting in New York decided to hold the plan of the Committee on World Production and Consumption of Petroleum and Its Products in abeyance.

"It was the unanimous opinion of the Institute directors," it was explained, "that the Institute cooperate with the Federal Oil Conservation Board in the study of its program and in any further efforts toward the conservation of petroleum, and that it should lend its aid in the continued study of any undertaking which promises best to bring about this result."

STATE ACTION

In May 1929, operators in Oklahoma asked the State Corporation Commission to increase the permitted output. This was granted May 13, 1929, when the commission advanced daily permitted production to 725,000 barrels daily from 650,000, and ruled that should output exceed that limit such prorationing as might become necessary would be applied only to the Greater Seminole area.

California wrote a chapter in the history of oil field conservation, when on May 28, 1929 Governor C. C. Young signed a new gas conservation law. Actually it was only an amendment to existing law relating to state control of water infiltration,

but in effect it extended state authority to production of crude oil by granting power to prevent the overproduction and waste of natural gas. All operators alike were affected by its provisions, and penalties were imposed on overproduction of both gas and oil in flush fields. The teeth of the law appear in this section:

“The unreasonable waste of natural gas by the act, omission, sufferance or insistence of the lessor, lessee or operator of any land containing oil or gas, or both, is hereby declared to be opposed to the public interest and is hereby prohibited and declared to be unlawful. The blowing, release, or escape of natural gas into the air shall be *prima facie* evidence of unreasonable waste.”

GOVERNOR'S CONFERENCE

On May 21, 1929, President Hoover invited governors of the oil producing states and, through the Federal Conservation Board, representatives of the oil industry to meet June 10, 1929 at Colorado Springs to consider the possibility of framing an interstate compact in cooperation with the federal government for better control of oil and gas well drilling and the prevention of waste. Later, representatives of the petroleum industry were invited to attend the conference, which was described as preliminary to government action in the matter of conserving petroleum resources and to be given over chiefly to discussion of fundamental principles rather than to preparation of any specific compact or other plan.

Directors of the Institute, in a resolution adopted May 28, 1929, accepted the invitation to attend the conference and appointed a committee to represent the organization.

The conference convened, with Mark L. Requa of California, special representative of President Hoover, presiding, and large delegations representing the federal government, the oil producing states, and the petroleum industry in attendance. After two days of discussion, it was found impossible to agree on any definite oil conservation plan; and this resolution, proposed by delegates representing the states of Texas, California, and Oklahoma, was adopted:

“The official delegates from the States of Texas, California, and Oklahoma, after a consultation among themselves, instead of making a recommendation for immediate action—believing, in view of the facts developed during the sessions of the conference concerning the main objectives sought to be accom-

plished by it, that a further study of the problems involved would likely attain better results—offer the following:

“To continue the work of the Conference of Governors called by the President and now in session, it is the judgment of the conference that a recess be taken subject to re-assembling upon call of the President of the United States. The governors of the several oil producing states are requested to be present upon such reconvening of the conference, and that they each bring with them, or send to the conference, three official delegates.”

The Institute's delegation submitted the following:

“In the event that the President and governors of some of the oil producing states decide to proceed further in the matter of an interstate conservation compact, the delegation representing the American Petroleum Institute resolves as follows:

“1. The American Petroleum Institute will cooperate with the federal and state agencies, if desired, in the further study of the feasibility of an interstate compact.

“2. This delegation believes it inadvisable to undertake at this meeting to agree upon a draft of an interstate compact.

“3. This delegation believes that such study should be conducted by a small committee representing the United States Government and the principal oil producing states, and that this committee should feel free not only to study the feasibility of an interstate compact to promote conservation, but the feasibility of any other method to accomplish the same purpose.

“4. We are of the opinion that coercive power to create or enforce police regulations within any given state cannot legally be conferred upon an interstate commission.

“The delegation representing the American Petroleum Institute clearly recognizes that this is a conference between representatives of the President and of the governors of the states represented, and that the Institute has no right to a vote in the conference; but in view of the invitation extended to the Institute to send representatives, this delegation feels that it is not an intrusion to submit this statement of its views.”

RESEARCH IN PETROLEUM

RESEARCH FUND

The work of research in petroleum is financed through a fund for scientific research in petroleum geology, physics, and chemistry established by John D. Rockefeller on November 15, 1925, under the auspices of the American Petroleum Institute. (See "Petroleum Facts and Figures," first edition, p. 234.) Commencing with 1926, annual installments of \$50,000 each were made available from the \$250,000 fund. An additional \$250,000, similarly payable in \$50,000 annual installments beginning 1926, was made available to the Institute by the Universal Oil Products Co., of Chicago, in furtherance of the same program.

The present trustees of the Rockefeller fund are: W. C. Teagle, president of the Standard Oil Co. of New Jersey; K. R. Kingsbury, president of the Standard Oil Co. of California; and W. R. Boyd, Jr., executive vice-president of the American Petroleum Institute.

The American Petroleum Institute has a Committee on Research with these members: W. C. Teagle, K. R. Kingsbury, Henry L. Doherty, president of H. L. Doherty & Co., J. Howard Pew, president of the Sun Oil Co., and Henry M. Dawes, president of the Pure Oil Co. Two vacancies had not been filled at the close of 1928.

The Institute has enlisted the assistance of the National Research Council, which fosters, encourages and coordinates cooperative research. The Council has established a Central Petroleum Committee, with members from the three interested divisions of the Council and from the Institute, to cooperate in the Institute's research program. The members are:

Division of Physical Science: L. H. Adams, Geophysical Laboratory, Carnegie Institution of Washington; Hugh S. Taylor, Professor of Physical Chemistry, Princeton University; R. A. Millikan, Director of the Norman Bridge Laboratory of Physics, California Institute of Technology.

Division of Chemistry and Chemical Technology: Marston T. Bogert, Professor of Chemistry, Columbia University; E. R. Weidlein, Director of Mellon Institute; Frank C. Whitmore, former Chairman of the Division, National Research Council.

Division of Geology and Geography: E. DeGolyer, Consulting Geologist, New York; K. C. Heald, Geologist, Gulf Oil Companies, Pittsburgh; David White, Chairman of the Division, National Research Council.

Representing the American Petroleum Institute: W. R. Boyd, Jr., executive vice-president; R. P. Anderson, Technologist; Van. H. Manning, former research director.

Under the present plan of procedure, qualified scientific personnel and existing laboratory equipment in universities, technical institutions and government bureaus are utilized in conducting the research program. Projects are considered by the Central Petroleum Committee and recommended to the Institute, which selects those to be supported.

RESEARCH PROJECTS

Thirty projects of research in petroleum now are under way in various institutions (during the period July 1, 1928 to June 30, 1930). They follow:

Project No.	Subject	Locale
1.	Generation of oil in Rock by Shearing Pressures	University of Wisconsin
2.	Action of Oxygen (and Air) on Cyclopentane and Cyclohexane Hydrocarbons with Side Chains	University of Brussels
3.	Study of Source Rocks in the Micro-Furnace	U. S. Geological Survey
4.	Origin and Environment of Source Sediments	Stanford University
5.	Diatoms as Source of Oil	Stanford University
6.	The Separation, Identification and Determination of the Chemical Constituents of Commercial Petroleum Fractions	U. S. Bureau of Standards
7.	Catalytic Methods Applied to Petroleum Hydrocarbons	Princeton University
8.	The Effect of Electric Discharge Upon Gaseous Hydrocarbons	University of Minnesota
9.	Analysis of Hydrocarbons by the Time Positive Ray Method	California Institute of Technology
11.	Analysis of Gradual Oxidation Prior to Ignition of Fuels in Internal Combustion Engines, and the Relation of Such Oxidation to Detonation	California Institute of Technology
12.	Accurate Comparison by Viscosity Methods Developed by Millikan of the Viscosities and Hence of the Mean Free Paths of Ring and Chain Hydrocarbons of the Same Molecular Weight and Composition	California Institute of Technology

Project No.	Subject	Locale
16.	A Study of Reactive Hydrocarbons	Harvard University
17.	Isolation and Study of the Sulfur Compounds Present in Petroleum	Northwestern University
18.	Non-Catalytic Thermal Decomposition of Pure Hydrocarbons and Related Compounds	Northwestern University
19.	A Study of the Relative Rates of Reaction of the Olefins	Massachusetts Institute of Technology
20.	Isolation and Investigation of Nitrogen Compounds Present in Petroleum	University of Texas
23.	Limestones and Dolomites as Reservoir Rocks	University of Illinois
25.	Determination of Geothermal Gradients in Oil Fields on Anticlinal Structure	University of Oklahoma, University of Texas, and University of California
26.	Determination of Thermal Conductivity of Gases and Its Application to the Precise Analysis of Hydrocarbons and Other Gases	U. S. Geological Survey
27.	The Displacement of Petroleum Oils from Oil-Bearing Sands by Use of Selected Aqueous Solutions	University of Michigan
28.	A Study of the Reactions of a Number of Selected Organic Sulphur Compounds	Johns Hopkins University
29.	An Investigation of the Heat Capacities and Free Energies of Some Typical Hydrocarbon Compounds	Stanford University
32.	The Equation of State of Certain Easily Liquefiable Hydrocarbons	University of Brussels
33.	The Effect of Natural Gas Upon the Viscosity, Surface Tension, Adhesion, and General Extractability of Petroleum of Various Types	University of Oklahoma
34.	The Fundamentals of the Retention of Oil by Sand I	California Institute of Technology
35.	The Fundamentals of the Retention of Oil by Sand II	California Institute of Technology
36.	The Fundamentals of the Retention of Oil by Sand III	California Institute of Technology
37.	The Fundamentals of the Retention of Oil by Sand IV	California Institute of Technology
38.	Thermodynamic Properties of Petroleum Hydrocarbons	U. S. Bureau of Standards
39.	Analysis of Crude Oil, its Distillates and Residues, for Unsaturated Hydrocarbons and Surface Active Matter by Means of the Dropping Mercury Cathode Method	Charles' University, Prague

RESULTS OF RESEARCH

Two yearly summaries of the work of these projects have been published as American Petroleum Institute bulletins: No. 54, September 21, 1927; and No 53, September 7, 1928. In addition, many articles have been published in various technical journals. The following articles have been published, or approved for publication, up to July 1, 1929:

Project
No.

1. Generation of Oil in Rocks by Shearing Pressure. I. The Problem—
Methods of Determining the Soluble Organic Content of Oil Shales.
II. Effect of Shearing Pressures on Oil Shales and Oil-Bearing Rocks.
Hawley.
Bull. Amer. Assn. Pet. Geol. **13**, 303-365 (1929).
3. Tests of Some "Mother Rocks" of Petroleum from Alaska. Stadnichenko.
Approved for publication, February 15, 1929.
4. Oceanography and Oil Deposits. Trask.
Trans. Amer. Geophysical Union. Bull. Nat. Res. Council 61, 235-42
(1927).
Results of Distillation of Some Modern Sediments. Trask.
Bull. Amer. Assn. Pet. Geol. **11**, 1221-30 (1927).
Limestone as a Source of Oil. Trask.
Bull. Amer. Assn. Pet. Geol. **12**, 556-7 (1928).
The Potential Value as Future Source Beds of Petroleum of Several Recent American Coastal and Inland Sediments. Trask.
Bull. Amer. Assn. Pet. Geol. **12**, 1057-68 (1928).
6. Apparatus and Methods for the Separation, Identification and Determination of the Chemical Constituents of Petroleum. Washburn, Bruun, Shepherd and Hicks.
Bur. Stds. J. Research, **2**, 468-88 (1929).
Rectifying Columns with Non-Siphoning Bubbling-Cap Plates. Bruun.
Approved for publication, March 1, 1929.
7. Equilibrium in the Reaction $\text{CH}_4 + 2\text{H}_2\text{O} \rightleftharpoons \text{CO}_2 + 4\text{H}_2$. Pease and Chesebro.
Jl. A. C. S. **50**, 1464-69 (1928).
The Thermal Dissociation of Ethane, Propane, Normal Butane and Isobutane. Preliminary Study. Pease.
Jl. A. C. S. **50**, 1779-85 (1928).
Equilibrium in the Reaction $\text{C}_2\text{H}_6 \rightleftharpoons \text{C}_2\text{H}_4 + \text{H}_2$. Pease & Durgan.
Jl. A. C. S. **50**, 2715-18 (1928).
Characteristics of Homogeneous, Exothermic Gas Reactions. Pease and Chesebro.
Proc. Nat. Acad. Sc. **14**, 472-5 (1928).
Characteristics of the Non-Explosive Oxidation of Propane and the Butanes. Pease.
Jl. A. C. S. **51**, 1839-56 (1929).
8. The Chemical Effect of Electrical Discharge in Ethane. Lind and Glockler.
Tr. Am. Electrochem. Soc. **52**, 37-46 (1927).
The Determination of Oxygen in Organic Compounds. Glockler and Roberts.
Jl. A. C. S. **50**, 828-31 (1928).

Project
No.

Control of the Molecular Weight of Liquid Hydrocarbons Produced by Electrical Discharge in Ethane. Lind and Glockler.

Jl. A. C. S. **50**, 1767-72 (1928).

The Chemical Effects of Semi-Corona Discharge in Gaseous Hydrocarbons. Lind and Glockler.

Approved for publication, April 24, 1929.

11. Analysis of the Gradual Oxidation Prior to Ignition of Fuels in Internal Combustion Engines and the Relation of Such Oxidation to Detonation. Millikan.

Approved for publication, August 7, 1928.

13. The Vaporization of Petroleums and Pressure Distillates. Fancher and Leslie.

Approved for publication, August 16, 1928.

14. The Synthesis of 1-Butene. Lucas and Dillon.

Jl. A. C. S. **50**, 1460-64 (1928).

The Preparation of Anhydrous Hydrogen Iodide. Lucas and Dillon.

Approved for publication, February 13, 1929.

Synthesis of Isomeric 2-Butenes. Young, Dillon and Lucas.

Approved for publication, March 19, 1929.

Researches on Butenes. III. The Reaction Rates of Potassium Iodide with 1, 2 and 2, 3--Dibromobutane and its Application to the Analysis of Mixtures of the Normal Butenes. Young, Dillon and Lucas.

Approved for publication, June 29, 1929.

15. Some Cyclopentane Derivatives. Case and Reid.

Jl. A. C. S. **50**, 3062-65 (1928).

16. The Action of Sodium-Potassium Alloy on Petroleum. Conant and Blatt.

Jl. A. C. S. **50**, 542-50 (1928).

The Action of Sodium-Potassium Alloy on Certain Hydrocarbons. Conant and Blatt.

Jl. A. C. S. **50**, 551-58 (1928).

The Action of the Grignard Reagent on Highly Branched Carbonyl Compounds. Conant and Blatt.

Approved for publication, November 2, 1928.

17. The Use of Organic Solvents for the Extraction of High Sulfur Oils from Crude Petroleum. Woodward.

Approved for publication, July 6, 1928.

A Volumetric Method for the Estimation of Sulfur in Crude Petroleum: An Adaptation of the Nikaido Method. Woodward.

Approved for publication, July 6, 1928.

Silica Gel as a Reagent for the Extraction of High Sulfur Oils from Crude Petroleum. Woodward.

Approved for publication, July 6, 1928.

18. The Pyrolysis of Hydrocarbons: I. Normal Butane and Isobutane. Hurd and Spence.

Approved for publication, January 27, 1929.

The Pyrolysis of Hydrocarbons: Isobutylene. Hurd and Spence.

Approved for publication, May 16, 1929.

19. Relative Rates of Reactions of Olefins in Combustion with Oxygen and in Oxidation with Aqueous Potassium Permanganate. Davis.

Ind. & Eng. Chem. **20**, 1055-57 (1928).

Project
No.

- The Relative Rates of Bromination of the Olefins. Davis.
Jl. A. C. S. **50**, 2769-80 (1928).
- The Relative Rates of Absorption of the Gaseous Butenes into Sulfuric Acid. Davis.
Jl. A. C. S. **50**, 2780-82 (1928).
- Problems in the Estimation of Unsaturated Hydrocarbons in Gases.
I. Separation by Fractional Distillation. Davis.
Ind. & Eng. Chem. (Analytical Edn.) **1**, 61-64 (1929).
20. The Estimation of Nitrogen in Petroleum and Bitumens. Poth, Armstrong, Cogburn and Bailey.
Ind. & Eng. Chem. **20**, 83-85 (1928).
A Receiver for Vacuum Distillation. Poth.
Ind. & Eng. Chem. (Analytical Edn.) **1**, 111-2 (1929).
21. A Modification of the Lamp Method for the Determination of Total Sulfur in Petroleum Distillates. Wood.
Approved for publication, February 14, 1929.
23. Method of Examining Calcareous Well Cuttings. Claypool and Howard.
Bull. Amer. Assn. Pet. Geol. **12**, 1147-52 (1928).
A Classification of Limestone Reservoirs. Howard.
Bull. Amer. Assn. Pet. Geol. **12**, 1153-61 (1928).
Limestone Oil Fields of the N. E. United States and Ontario, Canada. Murray.
Approved for publication, November 23, 1928.
- The Solubility of Limestone. I. Action of Organic Acids on Calcium Carbonate. Murray and Love.
Approved for publication, January 28, 1929.
27. A Method for the Measurement of Interfacial Tension of Liquid-Liquid Systems. Bartell and Miller.
Jl. A. C. S. **50**, 1961-67 (1928).
Degree of Wetting of Silica by Crude Petroleum Oils. Bartell and Miller.
Ind. & Eng. Chem. **20**, 738-42 (1928).
Oil & Gas July 19, 1928, p. 102.
Displacement of Crude Petroleum Oils with Selected Aqueous Solutions. Bartell and Miller.
Approved for publication, August 7, 1928.
28. Sulfur Compounds in Mineral Oils. Borgstrom and Reid.
Oil & Gas Jl. June 16, 1927, p. 352.
Estimation of Mercaptans in Naphtha. Borgstrom and Reid.
Approved for publication, August 10, 1928.
Preparation, Properties and Reactions of Lead Mercaptides. Borgstrom, Ellis and Reid.
Approved for publication, April 8, 1929.
29. The Entropies and Free Energies of Some Hydrocarbons. Parks.
Approved for publication, September 15, 1928.
32. Note on the Vacuum Contraction of Density Bulbs. Beckers.
Approved for publication, March 5, 1929.

STATISTICAL TABLES RELATIVE TO PETROLEUM

(SUMMARY OF STATISTICS CONTAINED IN AMERICAN PETROLEUM INSTITUTE BULLETIN NO. 18,

VOL. X, MARCH 12, 1929)

FORM No. 1—Production and Consumption of Crude Oil and Refined Products, Excess and Daily Average Excess of Production or Consumption

Roman face type indicates increase and *italic type* indicates decrease in stocks in columns 5 and 6. Roman type indicates excess of production and *italic type* indicates excess of consumption in columns 9 and 10

	Production and imports		Increase or decrease all stocks For detail see form No. 6		(a) Indicated consumption		Excess of production or consumption	
	Total (3) barrels	Daily average (4) barrels	Total (5) barrels	Daily average (6) barrels	Total (7) barrels	Daily average (8) barrels	Total (9) barrels	Daily average (10) barrels
Domestic crude oil production (1) barrels	Imports all oil (2) barrels							
1918.....	355,928,000	38,943,000	394,871,000	1,081,800	18,283,000	413,153,000	14,282,000	50,100
1919.....	378,367,000	54,161,000	432,528,000	1,185,000	6,767,000	425,761,000	6,767,000	18,500
1920.....	442,929,000	108,794,000	551,723,000	1,507,400	29,414,000	522,309,000	29,414,000	80,400
1921.....	472,183,000	128,776,000	600,959,000	1,646,500	81,658,000	519,301,000	81,658,000	223,700
1922.....	557,531,000	135,947,000	693,478,000	1,899,900	100,140,000	593,338,000	1,422,800	274,400
1923.....	732,407,000	99,608,000	832,015,000	2,279,500	101,787,000	730,228,000	1,625,500	278,900
1924.....	713,940,000	94,534,000	808,474,000	2,209,500	26,620,000	781,852,000	2,000,600	72,700
1925.....	763,743,000	78,137,000	841,880,000	2,306,500	30,994,000	811,786,000	2,136,200	82,400
1926.....	770,574,000	81,284,000	852,158,000	2,334,700	16,618,000	868,776,000	2,224,100	30,094,000
1927.....	901,126,000	71,662,000	972,791,000	2,665,200	67,456,000	905,335,000	16,618,000	45,500
1928.....	900,364,000	91,382,000	991,746,000	2,709,700	25,733,000	966,013,000	2,480,400	184,800
							25,733,000	70,300

NOTE—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables.

(a) Indicated consumption represents total consumption, including exports. (b) Does not include crude consumed as fuel on leases and changes in producers' stocks.

Authorities: Domestic crude oil production and stock changes from figures of Bureau of Mines. Imports from figures of Bureau of Foreign and Domestic Commerce. Increase or decrease in crude stocks at refineries includes all liquid stocks (crude and refined) for years 1918 to 1922, and all stocks for 1923 and subsequent.

PETROLEUM

FORM No. 2—Exports, Domestic Consumption and Excess of Domestic Consumption or Production of Crude Oil and Refined Products

	Exports				Fuel or bunker oil laden on vessels engaged in foreign trade (6) barrels	(b) Indicated domestic consumption (7) barrels	Excess of domestic consumption or production			
	(a) Indicated consumption (1) barrels	Foreign countries (2) barrels	Non-contiguous territories of the U. S. (3) barrels	Foreign oil (4) barrels			Total (5) barrels	Domestic production (8) barrels	Total (9) barrels	Daily average (10) barrels
1918.....	413,153,000	64,628,000	2,421,000	4,000	67,053,000	339,497,000	355,928,000	16,431,000	45,000	
1919.....	425,761,000	58,565,000	3,406,000	94,000	62,065,000	349,665,000	378,367,000	28,702,000	73,000	
1920.....	522,309,000	73,323,000	3,497,000	712,000	77,532,000	418,442,000	442,929,000	24,487,000	66,900	
1921.....	519,301,000	66,398,000	3,916,000	73,000	70,387,000	421,887,000	472,183,000	50,296,000	137,800	
1922.....	593,338,000	69,587,000	3,115,000	171,000	72,873,000	488,773,000	557,531,000	68,758,000	183,400	
1923.....	730,228,000	94,974,000	5,108,000	333,000	100,415,000	592,231,000	732,407,000	140,176,000	384,000	
1924.....	781,852,000	111,022,000	4,159,000	404,000	115,585,000	622,941,000	713,940,000	90,999,000	248,600	
1925.....	811,786,000	106,943,000	4,659,000	196,000	111,798,000	657,161,000	763,743,000	106,582,000	292,000	
1926.....	868,776,000	123,819,000	4,982,000	8,000	128,806,000	686,661,000	770,874,000	77,565,000	212,500	
1927.....	905,335,000	131,317,000	5,727,000	6,000	137,050,000	718,234,000	901,139,000	182,895,000	501,100	
1928.....	966,013,000	146,126,000	4,288,000	17,000	150,431,000	764,471,000	(c) 900,364,000	135,893,000	371,300	

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) "Indicated consumption" represents total consumption as shown in column 7 of Form No. 1 stocks. (b) "Indicated domestic consumption" in column 7 is difference between column 1 and columns 5 plus 6. (c) Does not include crude consumed as fuel on leases and changes in producers' stocks.

Authorities for basic figures are the same as in Form No. 1. "Exports" and "fuel or bunker oil" figures in columns 2 to 6 inclusive were taken from the Bureau of Foreign and Domestic Commerce reports.

FORM No. 3—Production of Crude Oil and Well Completions

(This table is an analysis of column No. 1, of statistical Form No. 1. The table analyzes the production of crude oil in the United States by fields)

	EASTERN			MID-CONTINENT			GULF COAST		
	Production barrels	Wells completed		Production barrels	Wells completed		Production barrels	Wells completed	
		Daily average barrels	Total		Daily average barrels	Total		Daily average barrels	Total
1918.....	41,988,000	115,000	8,287	179,883,000	491,500	14,800	24,208,000	66,300	1,637
1919.....	47,276,000	129,500	8,269	193,147,000	529,200	15,928	23,366,000	64,000	1,238
1920.....	44,494,000	121,500	11,060	190,111,000	693,400	19,938	27,682,000	75,600	1,760
1921.....	43,789,000	120,000	8,331	250,461,000	708,100	11,088	36,371,000	99,600	1,076
1922.....	41,680,000	114,200	8,203	310,992,000	852,000	12,742	37,117,000	101,700	1,380
1923.....	40,129,000	109,900	9,207	348,460,000	954,700	13,046	33,271,000	91,200	1,404
1924.....	38,090,000	104,100	8,308	375,479,000	1,025,900	13,468	28,569,000	78,100	949
1925.....	38,242,000	104,800	7,421	424,331,000	1,162,500	14,288	33,112,000	90,700	1,157
1926.....	39,114,000	107,200	7,943	423,867,000	1,161,300	17,600	45,275,000	124,000	1,255
1927.....	40,448,000	110,800	7,340	546,987,000	1,498,600	13,437	52,069,000	142,600	1,100
1928.....	40,662,000	111,100	6,995	552,980,000	1,510,900	12,437	45,719,000	124,900	1,299
	ROCKY MOUNTAIN			CALIFORNIA			TOTAL UNITED STATES		
	Production barrels	Wells completed		Production barrels	Wells completed		Production barrels	Wells completed	
		Daily average barrels	Total		Daily average barrels	Total		Daily average barrels	Total
1918.....	12,809,000	35,100	182	97,532,000	267,200	586	355,928,000	975,100	17,516
1919.....	13,383,000	36,700	286	101,183,000	277,200	559	378,367,000	1,036,600	20,966
1920.....	17,282,000	47,200	348	103,377,000	282,600	572	442,929,000	1,210,200	24,222
1921.....	20,950,000	57,400	326	112,600,000	308,500	704	472,183,000	1,293,600	14,350
1922.....	29,261,000	80,200	552	138,468,000	379,400	837	557,631,000	1,527,500	17,338
1923.....	47,653,000	130,600	699	262,876,000	720,200	980	732,407,000	2,006,600	16,279
1924.....	42,869,000	117,100	862	228,933,000	625,500	1,238	713,940,000	1,950,700	14,544
1925.....	35,554,000	97,400	986	232,492,000	637,000	948	763,743,000	2,092,400	16,523
1926.....	37,945,000	103,900	1,218	224,673,000	615,600	913	770,874,000	2,112,000	18,955
1927.....	30,429,000	83,400	1,063	231,196,000	633,400	901	901,129,000	2,468,800	14,571
1928.....	29,021,000	79,300	782	231,982,000	633,900	712	(b) 900,364,000	2,460,000	12,492

Note.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. Total United States production includes in 1918, 8,000 bbls.; in 1919, 12,000 bbls.; in 1920, 13,000 bbls.; in 1921, 12,000 bbls.; in 1922, 13,000 bbls.; in 1923, 18,000 bbls.; and in 1925, 12,000 bbls., credited to "Others" in U. S. Geological annual report. (a) Total completions for California not available. (b) Does not include crude consumed as fuel on leases and changes in producers' stocks.

Authorities: Production figures taken from Bureau of Mines preliminary reports, which are subject to correction. Figures for wells are compiled from the Oil and Gas Journal for all fields except California, and from the Standard Oil Bulletin and the American Petroleum Institute reports for California.

Form No. 5—Pipe Line and Tank Farm Crude Oil Stocks

(In columns showing "increase or decrease," Roman type indicates increases and *italic type* indicates decreases)

	EASTERN			MID-CONTINENT			GULF COAST		
	Stocks at end of period, barrels	Increase or decrease		Stocks at end of period, barrels	Increase or decrease		Stocks at end of period, barrels	Increase or decrease	
		Total barrels	Daily average barrels		Total barrels	Daily average barrels		Total barrels	Daily average, barrels
1918.....	7,012,000	<i>2,276,000</i>	<i>6,200</i>	79,094,000	<i>20,333,000</i>	<i>55,700</i>	8,188,000	<i>216,000</i>	<i>600</i>
1919.....	9,274,000	2,262,000	6,200	76,712,000	<i>2,332,000</i>	<i>6,500</i>	12,575,000	4,407,000	12,100
1920.....	7,430,000	<i>880,000</i>	<i>2,200</i>	75,690,000	14,984,000	40,900	11,163,000	<i>864,000</i>	<i>700</i>
1921.....	15,419,000	7,989,000	21,900	102,401,000	26,711,000	73,200	17,606,000	6,443,000	17,700
1922.....	19,693,000	4,274,000	11,700	132,573,000	50,172,000	137,400	24,971,000	7,175,000	19,700
1923.....	21,276,000	1,583,000	4,300	202,904,000	50,331,000	137,900	23,974,000	<i>807,000</i>	<i>2,300</i>
1924.....	21,377,000	101,000	300	210,558,000	7,654,000	20,900	20,200,000	<i>8,774,000</i>	<i>10,300</i>
1925.....	20,046,000	<i>1,331,000</i>	<i>3,700</i>	195,941,000	<i>14,617,000</i>	<i>40,000</i>	19,263,000	<i>697,000</i>	<i>2,600</i>
1926.....	20,226,000	180,000	500	173,848,000	<i>22,093,000</i>	<i>60,600</i>	20,031,000	768,000	2,100
1927.....	20,638,000	<i>219,000</i>	8,000	246,839,000	2,115,000	68,200	17,922,000	<i>543,000</i>	<i>11,100</i>
1928.....	18,031,000	<i>280,000</i>	<i>9,000</i>	265,807,000	1,628,000	52,500	18,304,000	98,000	<i>5,800</i>

	ROCKY MOUNTAIN			TOTAL EAST OF CALIFORNIA			CALIFORNIA		
	Stocks at end of period, barrels	Increase or decrease		Stocks at end of period, barrels	Increase or decrease		Stocks at end of period, barrels	Increase or decrease	
		Total barrels	Daily average, barrels		Total barrels	Daily average, barrels		Total barrels	Daily average, barrels
1918.....	915,000	399,000	1,100	95,189,000	<i>22,426,000</i>	<i>61,400</i>	28,538,000	1,833,000	<i>5,200</i>
1919.....	104,000	<i>761,000</i>	<i>2,100</i>	98,725,000	3,536,000	9,700	29,142,000	2,604,000	7,100
1920.....	636,000	135,000	400	94,919,000	14,035,000	38,400	20,890,000	<i>8,212,000</i>	<i>22,400</i>
1921.....	1,635,000	999,000	2,700	137,061,000	42,142,000	115,500	33,289,000	12,359,000	33,900
1922.....	1,991,000	356,000	1,000	199,038,000	61,977,000	169,800	49,375,000	16,086,000	44,100
1923.....	19,704,000	17,713,000	48,500	257,858,000	68,820,000	188,500	62,162,000	12,787,000	35,000
1924.....	28,672,000	8,968,000	24,500	280,807,000	12,949,000	35,400	.....	.....	.....
1925.....	28,995,000	323,000	900	294,245,000	<i>16,562,000</i>	<i>46,400</i>	.....	.....	.....
1926.....	28,075,000	<i>920,000</i>	<i>2,600</i>	242,180,000	<i>22,065,000</i>	<i>60,400</i>	.....	.....	.....
1927.....	27,238,000	<i>18,000</i>	600	312,637,000	1,505,000	48,500	.....	.....	.....
1928.....	23,501,000	<i>27,000</i>	<i>7,000</i>	327,643,000	1,033,000	33,300	.....	.....	.....

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. Commencing with January 1, 1921, the U. S. Geological Survey changed its method of reporting stocks. Stocks shown above for 1921 and all subsequent stocks are on the new basis.

Authority: Figures taken from Bureau of Mines monthly reports, which are subject to correction.

FORM NO. 6—Stocks of Crude Oil and Refined Products

	East of California		(b) Foreign crude oil in U. S. not at refineries (barrels) (3)	Refinable crude in Pacific coast territory (barrels) (4)	California pipe line and tank farm and refinery stocks of crude (barrels) (5)	Stocks of heavy crude including all grades of fuel in Pacific coast territory (barrels) (6)	(c) Stocks of refined products at refineries east of California (barrels) (7)	(e) Stocks of refined products in the Pacific coast territory (barrels) (8)	Total all stocks of crude and refined products (barrels) (9)
	Pipe line and tank farm crude oil stocks (barrels) (1)	Crude oil stocks at refineries (barrels) (2)							
1918.....	95 189,000	14 057,000	(d)	.....	28 231,000	.....	39 844,000	7 958,000	185 279,000
1919.....	98 725,000	11 793,000	(d)	.....	31 829,000	.....	42 582,000	7 117,000	192 046,000
(a) 1920.....	112 760,000	19 769,000	7 442,000	.....	22 422,000	.....	51 946,000	7 121,000	221 460,000
1921.....	137 061,000	25 053,000	13 540,000	.....	34 798,000	.....	66 160,000	8 665,000	285 277,000
1922.....	199 038,000	30 671,000	(b) 16 165,000	.....	52 509,000	.....	71 268,000	15 767,000	(d) 385 418,000
1923.....	267 858,000	27 716,000	1 383,000	(g)	67 705,000	.....	74 471,000	(i) 33 725,000	(e) 472 858,000
(f) 1924.....	280 807,000	31 184,000	734,000	40 541,000	.....	55 964,000	74 799,000	27 570,000	(f) 511 599,000
1925.....	264 245,000	(f) 27 157,000	407,000	(e) 44 451,000	.....	(ek) 84 983,000	94 104,000	26 346,000	(k) 541 693,000
1926.....	242 180,000	35 475,000	609,000	(f) 30 861,000	.....	(jm) 87 270,000	97 583,000	25 725,000	(m) 519 703,000
1927.....	312 637,000	(m) 39 317,000	84,000	20 086,000	.....	93 719,000	98 231,000	24 124,000	(n) 588 198,000
1928.....	827 643,000	40 529,000	259,000	16 995,000	.....	99 975,000	107 648,000	20 882,000	613 931,000

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Commencing January 1, 1921, the U. S. Geological Survey changed its method of reporting stocks, and for comparison with subsequent years this figure should read 94,919,000 bbls. (b) Prior to January 1, 1923, Mexican stocks included topped oil and duplication of crude at refineries. Mexican stocks on hand December 31, 1922, comparable with those of subsequent months, amounted to 1,818,000 bbls. (c) Prior to January 1923, only liquid stocks at refineries were used. Total stocks at U. S. refineries at end of December 1922, comparable with those of subsequent months, amounted to 89,643,000 bbls. (d) Mexican stocks not available prior to January 1920. (e) During August, 1,180,000 bbls. were transferred from stocks of refinable crude to heavy crude and fuel oil stocks. (f) During August, there were added 1,462,000 bbls. of pipe line crude not previously reported. (g) Stocks refinable crude in Pacific Coast territory on December 31, 1923, comparable with subsequent months, amounted to 35,098,000 bbls. (h) Stocks of heavy crude, including all grades of fuel in Pacific Coast territory on December 31, 1923, comparable with subsequent months, amounted to 49,612,000 bbls. (i) Due to change of method in reporting stocks in California, stocks of refined products in the Pacific Coast territory, comparable with subsequent months, amounted to 27,379,000 bbls. (j) See notes on Form 6 (Cont'd) for explanation of fire loss in California. (k) Due to inclusion of 800,000 bbls. of pipe line working stocks, not previously reported, stocks on December 31, 1925, comparable with subsequent months, amounted to 86,783,000 bbls. (l) Due to inclusion of crude in transit to refineries, not previously reported, stocks on December 31, 1925, comparable with subsequent months, amounted to 29,240,000 bbls. (m) During June 1927, there were approximately 1,300,000 bbls., previously classified as refinery crude, transferred to pipe line crude stocks. (n) Due to revision of figures during 1927, stocks of heavy crude, including all grades of fuel in Pacific Coast territory on December 31, 1928, comparable with subsequent months, amounted to 88,309,000 bbls.

Authorities: Figures taken from Bureau of Mines reports.

FORM NO. 6 (Continued)—Increase or Decrease in Stocks of Crude Oil and Refined Products

(Roman type indicates increase and *italic type* indicates decrease)

	East of California		Foreign crude oil in U. S. not at refineries	Refinable crude in Pacific coast territory	California pipe line and tank farm and refinery stocks of crude	Stocks of heavy crude including all grades of fuel in Pacific coast territory	Stocks of refined products at refineries east of California	Stocks of refined products in the Pacific coast territory	Net increase or decrease all stocks of crude and refined products
	Pipe line and tank farm crude oil stocks (barrels)	Crude oil stocks at refineries (barrels)	(barrels)	(barrels)	(barrels)	(barrels)	(barrels)	(barrels)	(barrels)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1918.....	3,535,000	2,284,000	.....	.....	3,598,000	.....	2,738,000	841,000	6,767,000
1919.....	14,035,000	7,976,000	.....	.....	<i>9,407,000</i>	.....	9,364,000	4,000	28,414,000
1920.....	42,142,000	5,284,000	6,442,000	.....	12,376,000	.....	14,214,000	1,544,000	81,658,000
1921.....	61,377,000	5,617,000	6,098,000	.....	17,711,000	.....	5,108,000	7,102,000	100,140,000
1922.....	68,820,000	2,965,000	2,625,000	.....	15,196,000	.....	3,203,000	17,958,000	101,787,000
1923.....	11,487,000	3,465,000	649,000	.....	.....	6,352,000	328,000	191,000	28,620,000
1924.....	16,562,000	4,027,000	387,000	5,443,000	.....	27,859,000	19,305,000	1,824,000	30,094,000
1925.....	22,065,000	6,275,000	202,000	5,090,000	.....	(b) 4,691,000	3,479,000	(c) 210,000	16,618,000
1926.....	70,457,000	3,842,000	595,000	10,776,000	.....	5,410,000	648,000	1,601,000	67,456,000
1927.....	.....	.....	.....	.....	.....	6,256,000	9,417,000	5,242,000	25,733,000
1928.....	15,008,000	1,212,000	175,000	3,091,000	.....	.....	.....	.....	.....

See Form No. 6 for explanation of general notes. (a) Does not include 4,600,000-barrel fire loss. (b) Does not include 3,204,000-barrel fire loss. (c) Does not include 411,000-barrel fire loss. (d) Does not include 8,215,000-barrel fire loss in California.

Form No. 7—Production, Imports, Stocks, Exports and Domestic Consumption of Crude Oil

(Roman type indicates increase and *italic type* indicates decrease in columns 6 and 7)

Domestic crude oil production			(t) Imports of crude oil		(a) Stocks, crude oil		(e) Exports of crude oil		Indicated domestic consumption of crude oil	
Total barrels (1)	Daily average barrels (2)	Total barrels (3)	Daily average, barrels (4)	End of period, barrels (5)	Total barrels (6)	Daily average, barrels (7)	Total barrels (8)	Daily average, barrels (9)	Total barrels (10)	Daily average barrels (11)
1918.....	355,928,000	37,736,000	103,400	137,477,000	20,803,000	55,400	5,884,000	16,100	407,983,000	1,117,800
1919.....	378,367,000	1,036,600	144,700	142,347,000	4,870,000	13,400	6,253,000	17,100	420,065,000	1,150,800
1920.....	442,929,000	1,210,200	106,175,000	163,393,000	21,382,000	58,400	8,583,000	23,500	519,139,000	1,418,400
1921.....	472,183,000	1,293,700	125,384,000	210,453,000	65,901,000	180,600	9,552,000	26,200	522,094,000	1,430,400
1922.....	557,531,000	1,527,500	356,000	288,583,000	87,930,000	240,900	10,637,000	29,200	589,219,000	1,614,300
1923.....	732,407,000	2,006,600	224,700	(c) 364,662,000	80,626,000	220,900	17,210,000	47,200	716,586,000	1,963,200
1924.....	713,940,000	1,950,700	212,500	(b) 353,266,000	21,211,000	58,000	17,871,000	48,800	752,634,000	2,056,400
1925.....	763,743,000	2,092,400	169,400	(f) 336,260,000	17,006,000	46,600	13,127,000	36,000	829,446,000	2,272,000
1926.....	770,874,000	2,112,000	163,400	(g) 309,125,000	24,678,000	67,400	15,356,000	42,100	840,478,000	2,302,700
1927.....	901,129,000	2,468,800	160,000	.....	62,993,000	172,600	15,843,000	43,400	880,669,000	2,412,800
1928.....	(h) 900,304,000	2,460,000	217,400	.....	13,302,000	36,300	18,962,000	51,800	947,682,000	2,589,300

Notes.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Includes all stocks of crude oil in the United States for 1923 and prior; but beginning with January 1924, figures include all crude stocks east of California, and in California the *refinable crude stocks only*. (b) Stocks on December 31, 1923, comparable with subsequent months, amounted to 332,055,000 barrels. (c) Due to reduction in stocks because of duplication of Mexican crude at refineries (See note (b) Form 6), the total stocks on December 31, 1922, comparable with December 31, 1923, amounted to 284,036,000 barrels. (d) Prior to year 1923, topped oil is included. (e) Includes exports to foreign countries and to U. S. insular possessions. (f) Due to inclusion of crude in transit to refineries, not previously reported, total stocks on December 31, 1925, comparable with subsequent months, amounted to 338,303,000 barrels. (g) Does not include 4,600,000 barrels of refinable crude destroyed by fire in California. (h) Does not include crude consumed as fuel on leases and changes in producers' stocks. Authorities: Domestic crude oil production and stock figures are taken from Bureau of Mines reports. Imports and exports from reports of Bureau of Foreign and Domestic Commerce.

FORM No. 8—Production, Imports, Stocks, Exports and Domestic Consumption of Refined Gasoline

(Roman type indicates increase and *italic type* indicates decrease in stocks in columns 6 and 7)

	(a) Production			Imports		Stocks		(b) Exports		Indicated domestic consumption	
	Total barrels (1)	Daily average, barrels (2)	End of period barrels (5)	Total barrels (3)	Daily average, barrels (4)	Increase or decrease		Total barrels (8)	Daily average, barrels (9)	Total barrels (10)	Daily average, barrels (11)
						Total barrels (6)	Daily average, barrels (7)				
1918.....	85,007,000	232,900	7,080,000	307,000	800	<i>2,736,000</i>	<i>7,500</i>	13,544,000	37,100	74,506,000	204,100
1919.....	94,235,000	258,200	10,638,000	203,000	600	3,558,000	9,800	9,097,000	24,900	81,783,000	224,100
1920.....	116,251,000	317,600	11,009,000	964,000	2,600	371,000	1,000	15,636,000	42,700	101,208,000	276,500
1921.....	122,704,000	336,200	13,954,000	900,000	2,500	2,945,000	8,100	13,134,000	36,000	107,525,000	294,600
1922.....	147,672,000	404,600	21,043,000	1,479,000	4,000	7,089,000	19,400	14,156,000	38,800	127,906,000	350,400
1923.....	179,903,000	492,900	30,823,000	4,555,000	12,500	4,550,000	12,500	20,741,000	56,800	159,167,000	436,100
1924.....	213,326,000	582,900	38,875,000	3,453,000	9,400	2,809,000	7,700	28,967,000	79,100	185,063,000	505,500
1925.....	259,601,000	711,200	38,875,000	3,813,000	10,500	8,054,000	22,100	31,497,000	86,300	223,863,000	613,300
1926.....	299,734,000	821,200	39,023,000	5,540,000	15,200	148,000	400	43,313,000	118,700	261,813,000	717,300
1927.....	330,435,000	905,300	.....	5,003,000	13,700	<i>6,382,000</i>	<i>17,500</i>	44,337,000	121,500	297,453,000	815,000
1928.....	377,183,000	1,030,600	.....	4,297,000	11,700	425,000	1,200	53,803,000	147,000	327,252,000	894,100

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Output of U. S. refineries. (b) Includes exports (classified "gasoline, naphtha, etc.") to foreign countries and U. S. insular possessions. (c) Due to revised method of reporting stocks in California, total stocks of gasoline in U. S. on December 31, 1923, comparable with subsequent months, amounted to 28,014,000 barrels.

Authorities: Figures for "production" and "stocks" are taken from Bureau of Mines reports, and those for "imports" and "exports" from the Bureau of Foreign and Domestic Commerce reports.

Form No. 9—Production, Imports, Stocks, Exports and Domestic Consumption of Kerosene
(Roman type indicates increase and *italic type* indicates decrease in stocks in columns 6 and 7)

	(a) Production		Imports		Stocks		(b) Exports		Indicated domestic consumption	
	Total barrels	Daily average, barrels	Total barrels	Daily average, barrels	End of period barrels	Total barrels	Daily average, barrels	Total barrels	Daily average, barrels	Total barrels
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1918.....	43,461,000	119,100	.....	.....	9,050,000	2,801,000	7,700	11,820,000	32,400	34,442,000
1919.....	55,753,000	152,700	.....	.....	8,079,000	971,000	2,700	23,556,000	64,500	94,400
1920.....	55,240,000	150,900	.....	.....	9,359,000	1,280,000	3,500	20,878,000	57,000	90,900
1921.....	46,313,000	126,900	.....	.....	8,119,000	1,240,000	3,400	18,016,000	49,400	90,400
1922.....	54,913,000	150,500	(c)	.....	6,692,000	1,427,000	3,300	21,489,000	58,900	80,900
1923.....	55,927,000	153,200	7,000	.....	(d) 6,743,000	51,000	100	20,347,000	55,800	93,500
1924.....	60,026,000	164,000	10,000	.....	8,594,000	1,363,000	3,700	21,961,000	50,000	97,300
1925.....	59,689,000	163,500	19,000	100	7,121,000	1,473,000	4,000	21,212,000	58,100	100,300
1926.....	61,768,000	169,200	75,000	200	8,575,000	1,454,000	4,000	22,248,000	60,900	109,500
1927.....	56,113,000	153,700	54,000	100	.....	860,000	2,400	19,520,000	53,500	102,700
1928.....	60,156,000	164,400	203,000	500	.....	1,286,000	3,500	22,066,000	60,300	101,100

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Output of U. S. refineries. (b) Includes exports (classified "illuminating oil") to foreign countries and U. S. insular possessions. (c) Imports prior to October 1922, not available. (d) Due to revised method of reporting stocks in California, total stocks of kerosene in U. S. on December 31, 1923, comparable with subsequent months, amounted to 7,231,000 barrels.

Authorities: Figures for "production" and "stocks" are taken from Bureau of Mines reports, and those for "imports" and "exports" from the Bureau of Foreign and Domestic Commerce reports.

Form No. 10—Production, Imports, Stocks, Exports and Domestic Consumption of Refined Gas and Fuel Oils

(Roman type indicates increase and *italic type* indicates decrease in stocks in columns 6 and 7)

	(a) Production			Imports		Stocks		(b) Exports		Indicated domestic consumption	
	Total barrels (1)	Daily average, barrels (2)	End of period barrels (5)	Total barrels (3)	Daily average, barrels (4)	Increase or decrease		Total barrels (8)	Daily average, barrels (9)	Total barrels (10)	Daily average, barrels (11)
						Total barrels (6)	Daily average, barrels (7)				
1918.....	174,319,000	477,600	15,691,000	.....	.....	1,931,000	5,300	29,636,000	81,200	142,752,000	391,000
1919.....	181,602,000	497,500	17,003,000	.....	.....	1,312,000	3,600	19,487,000	45,100	163,803,000	448,800
1920.....	210,987,000	576,500	19,938,000	.....	.....	2,935,000	8,000	22,080,000	60,500	185,972,000	508,200
1921.....	230,931,000	630,400	31,687,000	.....	.....	11,759,000	32,200	22,676,000	62,100	195,656,000	536,100
1922.....	254,910,000	698,400	31,065,000	.....	.....	632,000	1,700	23,470,000	50,600	237,063,000	649,500
1923.....	287,480,000	787,600	38,072,000	.....	.....	5,007,000	13,700	33,372,000	91,000	261,387,000	716,100
1924.....	320,476,000	875,600	75,520,000	.....	.....	6,388,000	14,700	37,248,000	101,800	290,768,000	794,400
1925.....	364,991,000	1,000,500	12,927,000	.....	.....	34,144,000	93,500	38,098,000	98,000	307,004,000	841,100
1926.....	365,195,000	1,000,500	12,245,000	.....	.....	13,400	38,500	35,331,000	105,100	336,368,000	921,500
1927.....	393,066,000	1,076,900	11,168,000	.....	.....	4,308,000	39,800	47,391,000	129,800	339,264,000	929,500
1928.....	425,755,000	1,163,300	.....	.....	.....	14,534,000	39,800	44,457,000	121,500	381,408,000	1,042,100
						7,160,000	19,600				

NOTE.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Output of U. S. refineries. (b) Includes exports (classified "gas, fuel oil, and residuum") to foreign countries and U. S. insular possessions, and does not include fuel or bunker oil laden on vessels engaged in foreign trade. (c) Imports prior to October 1923, not available. (d) Includes all stocks of refined gas and fuel oil in U. S. for 1923 and prior, but for January 1924 and subsequent months stocks include refined gas and fuel oil east of California, and in California stocks of heavy crude including all grades of fuel. (e) Stocks on December 31, 1923, comparable with subsequent months, amounted to 70,132,000 barrels. (f) Due to inclusion of 800,000 barrels of pipe line working stocks, not previously reported, stocks on December 31, 1925, comparable with subsequent months, amounted to 110,464,000 barrels. (g) Does not include 3,204,000 barrels of heavy crude destroyed by fire in California. (h) Due to revision in stocks of heavy crude, including all grades of fuel oil in California, stocks on December 31, 1926, comparable with subsequent months, amounted to 113,207,000 barrels.

Authorities: Figures for "production" and "stocks" are taken from Bureau of Mines reports, and those for "imports" and "exports" from the Bureau of Foreign and Domestic Commerce reports.

FORM NO. 11—Production, Imports, Stocks, Exports and Domestic Consumption of Lubricants

(Roman type indicates increase and *italic type* indicates decrease in stocks in columns 6 and 7)

	(a) Production			Imports		Increase or decrease		(b) Exports		Indicated domestic consumption	
	Total barrels	Daily average, barrels	End of period barrels	Total barrels	Daily average, barrels	Total barrels	Daily average, barrels	Total barrels	Daily average, barrels	Total barrels	Daily average, barrels
	(1)	(2)		(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
			(5)								(11)
1918		54,900	3,308,000	.....	...	48,000	100	6,165,000	16,900	13,822,000	37,900
1919		55,200	3,269,000	.....	...	37,000	100	6,598,000	18,100	13,600,000	37,300
1920		58,100	3,822,000	.....	...	533,000	1,500	9,643,000	26,300	14,742,000	40,300
1921		57,200	5,735,000	.....	...	1,913,000	5,200	6,836,000	19,000	12,047,000	33,000
1922		63,900	5,513,000	.....	...	122,000	900	7,941,000	21,800	15,485,000	42,400
1923		71,600	6,781,000	29,000	100	168,000	500	8,372,000	22,900	17,617,000	48,300
1924		75,200	6,420,000	11,000	...	282,000	800	9,103,000	24,900	18,124,000	49,500
1925		85,100	7,253,000	37,000	100	833,000	2,300	9,678,000	26,500	20,581,000	56,400
1926		88,500	7,576,000	33,000	100	323,000	900	9,348,000	25,600	22,655,000	62,100
1927		86,900	.....	8,000	...	284,000	800	9,732,000	26,600	21,713,000	59,500
1928		94,700	.....	13,000	...	480,000	1,300	10,657,000	29,900	23,235,000	63,500

Note.—The 42-gallon barrel unit is used uniformly in the Institute's statistical tables. (a) Output of U. S. refineries. (b) Includes exports to foreign countries and U. S. insular possessions. (c) Imports prior to October 1922, not available. (d) Due to revised method of reporting stocks in California, total stocks in U. S. on December 31, 1923, comparable with subsequent months amounted to 6,138,000 barrels. (e) Figures for "production," "stocks," and "imports" are taken from Bureau of Mines reports, and those for "exports" from the Bureau of Foreign and Domestic Commerce reports.

NATIONAL CODE OF PRACTICES FOR MARKETING REFINED PETROLEUM PRODUCTS

The Federal Trade Commission has acted upon the recommendation of the petroleum industry, and approved a "National Code of Practices for Marketing Refined Petroleum Products." The announcement of the commission, dated July 25, 1929, containing the full text of the code authorized is set forth below.

In promulgating codes of business practices, the commission classifies the provisions of such codes under two sub-divisions, namely Group 1, or "Approved Practices"; Group 2, or "Expressions of the Trade."

The Group 1 classification—"Approved Practices"—contains those provisions of the code prohibiting practices which are regarded in law as unfair methods of competition.

Section 5 of the Federal Trade Commission Act reads as follows:

"That unfair methods of competition in commerce are hereby declared unlawful. The commission is hereby empowered and directed to prevent persons, partnerships, or corporations, except banks and common carriers subject to the acts to regulate commerce, from using unfair methods of competition in commerce."

This authorizes the commission to proceed formally against any one practicing an unfair method of competition, whether prohibited by a code of practices or not.

The Group 2 classification—"Expressions of the Trade"—contains rules covering practices which the commission does not regard as being violative of law, the observance of which rules, however, the industry believes would be to its advantage. The enforcement of this second group of rules depends entirely upon the good faith and cooperation of the members of the industry.

The full text of the code follows:

GROUP I

RULE 1.

The practice of loaning or leasing gasoline pumps, tanks, and other equipment is unsound and uneconomic, and should

be discontinued at the earliest possible moment, consistent with existing conditions. Until such time as this situation can be brought about, and only in those states in which the practice is now observed, gasoline or kerosene pumps and tanks, motor oil equipment and grease outfits (the grease outfits not exceeding in cost \$50 each) may be loaned or leased for the exclusive storage and handling of the products of the lender or lessor, but the borrower or lessee shall not be prohibited from handling in other equipment the products of another supplier. Where no equipment is at present installed by any company, or where additional equipment may be added to existing locations, the borrower or lessee shall be required to pay for the installation of each loaned or leased equipment the actual cost of installing said equipment, and for this purpose shall make a cash deposit of at least \$100 in advance for each underground unit to be installed, and shall pay, as or when due, all privilege taxes attaching because of the installation or maintenance of such equipment.

(Note by commission: That part of this rule which relates to handling, by the borrower of equipment, of the products of a supplier other than those of the lender of the equipment is approved as a Group I rule—the other portions of the rule being treated, independently, as belonging in Group II.)

RULE 2.

Refining companies, wholesalers, distributors, and/or jobbers may acquire by *bona fide* leases or sub-leases, service and filling stations or sites for same, such stations and/or sites may be leased or licensed by such company to dealers for the purpose of distributing its products. Such stations and/or sites shall not be acquired at one rental and then sub-leased or licensed at a reduced rental for the purpose of rebating. In the event the company makes improvements to such properties prior to sub-leasing same, such sub-lease shall provide in addition for reasonable return upon the cost of such improvements, in order that the transaction may not result in rebating.

RULE 3.

No company shall paint over any sign or colors of another company until it has communicated with the company whose signs or colors are involved, inquiring whether or not the latter company has any written contract which would be violated by the proposed painting. The latter company shall respond promptly, giving the information requested; and if it holds a contract which would be violated, shall offer to submit

it for inspection at its office. If the contract so submitted discloses that the proposed painting would constitute a breach of the contract, the painting shall not be done.

RULE 4.

No refiner, distributor, jobber, or wholesaler shall knowingly induce, attempt to induce, or assist a party to break an existing written contract for the sale of petroleum products between that party and another.

RULE 5.

All above-ground equipment for refined products shall bear in a conspicuous place the name or trade-mark of the owner or lessor; and no refiner, distributor, jobber, wholesaler or retailer shall knowingly deliver into such equipment any refined product other than the brand designated, or in any way be a party to the substitution of one grade or brand of refined products for another.

RULE 6.

Lotteries, prizes, wheels of fortune, and/or other games of chance shall not be used in connection with the sales of gasoline or motor oils.

RULE 7.

The selling of refined petroleum products below cost for the purpose of injuring a competitor, and with the effect of lessening competition, is an unfair trade practice.

GROUP II

RULE 8.

On account of the special nature of service required in supplying petroleum products to airports, no dispensing or storage equipment of any kind shall be leased, loaned, or otherwise furnished, to airport operators or resellers of petroleum products, except at full cost, including cost of equipment and storage installation.

RULE 9.

A lender or lessor of equipment shall neither extend credit to the borrower or lessee for installation costs, nor advance money to him to cover payment of privilege taxes, or any other expense in any manner related to the installation of loaned or leased equipment.

It is not the intention of Rule 1 and Rule 9 to require the payment of installation costs from the borrower or lessee for exchanges and/or substitution in existing equipment on locations where gasoline, kerosene or lubricating oils are being sold upon the date of the Federal Trade Commission's approval of this code. The privilege of exchange or substitution of equipment is declared to extend to all dealers, not merely to the original lenders.

RULE 10.

Except as may be provided in Rule 2, refiners, wholesalers, distributors and/or jobbers shall not construct for retailers any driveways, canopies, sheds, greasing pits, building or other structures; do painting other than their standard signs or loaned equipment; make improvements to existing structure or facilities; nor furnish or loan air compressors, greasing lifts or racks, or other things of value, except equipment stated in Rule 1 hereof, nor bear any part of the expense of construction work on the premises of resellers, nor loan money for the same.

RULE 11.

No equipment except trade-marked pump globes and other standard advertising devices shall be loaned to tank car buyers and/or distributors.

RULE 12.

Refiners, distributors, jobbers, and/or wholesalers shall not pay rentals or make any allowance for the privilege of installing pumps and tanks, or for displaying advertising on premises where refined products are sold.

RULE 13.

Refiners, distributors, jobbers, and/or wholesalers shall not rent from any dealer or consumer any delivery equipment, and shall not purchase from any dealer or consumer any delivery equipment for more than its actual value.

RULE 14.

Refining companies, wholesalers, distributors, and/or jobbers may own service and filling stations or sites for same, and may lease such stations and/or sites to dealers for purposes of distributing its products, provided that such leases shall stipulate for a reasonable return to the lessor upon the then fair value of the property for filling station purposes.

RULE 15.

Gasoline shall not be sold from tank wagons or trucks to other motor vehicles except in emergency cases.

RULE 16.

No oil or other thing of value shall be given away, or special inducement granted, on opening days, special sale days, or other occasions.

RULE 17.

All refiners, distributors, jobbers, and wholesalers shall conspicuously post, at each point from which they make delivery, the several posted prices of gasoline and kerosene for each class of delivery for such deliveries at the time of delivery.

Retailers and other operators serving consumers through service stations, garages, curb pumps, or pumps located at bulk plants, shall conspicuously post, at the place from which delivery is made, prices at which gasoline, kerosene, and motor oils are sold.

No seller shall make any deviation from his posted prices (whether wholesale or retail) by means of rebates, allowances, bonuses, concessions, benefits, unusual credits, scrip books, or any plan, device, or other scheme which may directly or indirectly permit the buyer to obtain gasoline or kerosene at a lower net cost to him.

Commercial accounts, whether for delivery at service stations or otherwise, may be recognized as an exception to this rule in sections where they are now in vogue, but shall apply only to written contracts for charge accounts.

RULE 18.

The practice of making deliveries of gasoline at refineries or wholesale plants into tank wagons or trucks operated by or for the purchasers thereof is discouraged.

RULE 19.

Coupon books or other scrip of any nature, if used, shall be sold and redeemed at their face value without any discount.

RULE 20.

On a change in the posted price, no adjustments, allowances, credits or refunds shall be given to any buyer on deliveries already made.

RULE 21.

Definitions.

For the purpose of this code, the following definitions are adopted:

(a) *Consumer.* One who destroys the exchangeable value of a commodity by using it. He is an eligible buyer from service station, tank wagon, tank car, or in packages.

(b) *Refiner.* One who refines crude petroleum and natural gas into refined products.

(c) *Jobber, Distributor, or Wholesaler.* One who carries a stock of petroleum products to sell to retail dealers or others for resale, but who may also sell direct to consumers.

(d) *Retail Dealer.* One who carries a stock of petroleum products to sell to the consumers only.

(e) *Commercial Accounts.* Petroleum products sold to persons, firms, or corporations using commercial vehicles in transportation or delivery of passengers, merchandise, freight or express, for use only in such vehicles properly licensed by public authorities for those purposes.

PURPOSES OF THE AMERICAN PETROLEUM INSTITUTE

THE AMERICAN PETROLEUM INSTITUTE was formed in 1919, an outgrowth of the activities of the National Petroleum War Service Committee, which service revealed the advisability and necessity of a permanent organization of such character. The Institute is an association of more than four thousand persons engaged in the oil and allied industries. Membership is individual, and companies, as such, are not members.

The objects of the Institute as expressed in its charter are as follows:

- (a) To afford a means of cooperation with the government in all matters of national concern; and
- (b) To foster foreign and domestic trade in American petroleum; and
- (c) To promote in general the interests of the petroleum industry in all its branches; and
- (d) To promote the mutual improvements of its members and the study of the arts and sciences connected with the petroleum industry.

The principal activities of the Institute are: Accounting and taxation; development and production engineering; fundamental research, embracing problems of physics, chemistry, and geology; public relations; standardization of oil field equipment and methods; statistics; technology, embracing technical and engineering problems of refining, oil pollution, fire prevention, automotive transportation, corrosion, specifications of petroleum products, motor fuel research, etc.; and railroad transportation, embracing all problems of transportation of petroleum and its products, except freight rates.

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